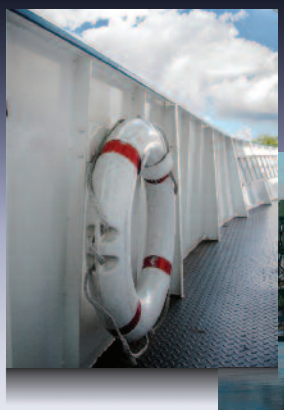

Safety Profile of the Great Lakes-St. Lawrence Seaway System

Prepared by the Research and Traffic Group

March 2014

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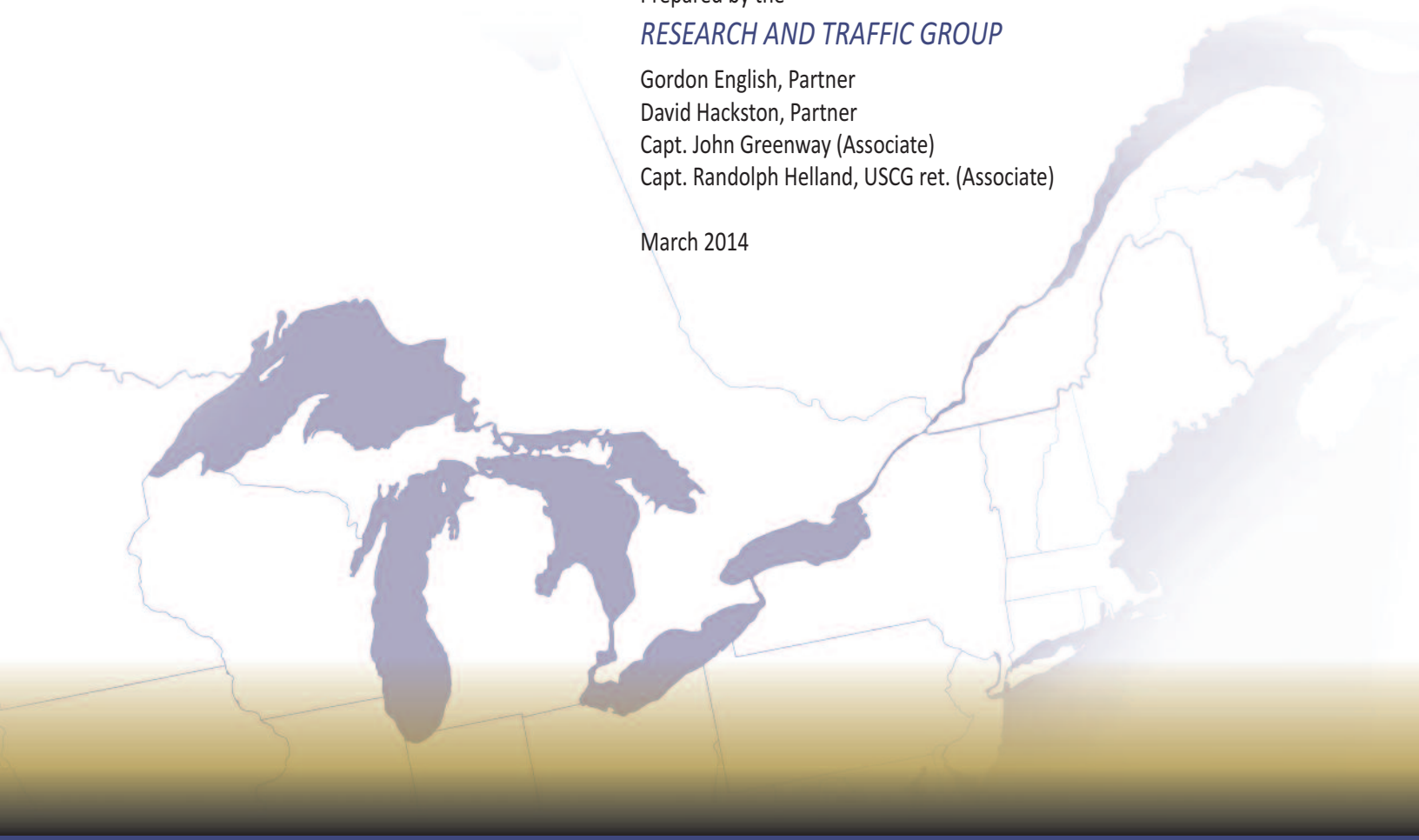


Table of Contents

List of Tables and Figures

List of Tables

List of Figures

Acronyms and Definitions

Acronym	*Definition*
AIS	Automatic Identification System
CCG	Canadian Coast Guard
ECDIS	Electronic Chart Display And Information System
ECS	Electronic Chart System
Gallon	U.S. gallon
GPS	Global Positioning System
GRT	Gross registered tonnage
IACS	International Association of Classification Societies
IMO	International Maritime Organization
ISM	International Safety Management
ISO	International Organization for Standardization
OSLTF	Oil Spill Liability Trust Fund
SLSDC	Saint Lawrence Seaway Development Corporation
SLSMC	St. Lawrence Seaway Management Corporation
SOLAS	Safety of Life at Sea
SOPF	Ship-source Oil Pollution Fund
STCW	Standards for the Training and Certification of Watchkeepers
Ton	2,000 pounds
Tonne	2,204 pounds
TSB	Canadian Transportation Safety Board
USCG	United States Coast Guard
VHF	Very High Frequency

About the Study Authors and Acknowledgments

For more than two decades, Research and Traffic Group has provided advice and assistance to clients, and undertaken important studies, particularly in transportation. Brief resumes of the qualifications and experience of the Partners and Associates involved in this safety profile are provided below:

Gordon English (B.Sc., M.B.A., P.Eng.)

Gordon English has been a partner at Research and Traffic Group since 1999, and an active associate since 1994, leading projects focused on energy, safety and techno-economic feasibility evaluations, including five climate change evaluations, four energy/emissions modal comparison projects, several transportation safety impact assessments and a discussion paper on internalizing social costs in the transportation sector. English has more than 37 years' experience conducting transportation-related research. He is also currently the President of TranSys Research Ltd, which has focused on safety and techno-economic analyses for projects such as the economic viability of railway operations in an asset devolution assessment for the St. Lawrence Seaway and recommendations to the Republic of China on proposals for high-speed rail passenger service between Taipei and Kaohsiung. He also previously worked as the Director of Research for the Canadian Transportation Safety Board Act Review Commission and in various positions at the Canadian Institute of Guided Ground Transport at Queen's University.

David C. Hackston (B.Comm., B.Arts, FCILT)

David Hackston has been a partner at Research and Traffic Group since 1988, assisting clients with analyses related to rail transportation, intermodal and Great Lakes-Seaway issues. He has more than 40 years' experience in the transportation sector, including providing the Canada Transportation Act Review with expert advice on rail freight and passenger (intercity and urban) issues. From 1974 to 1987, he served with the Canadian Transport Commission as Executive Director, Traffic and Tariffs, advising on rates and public interest issues for rail, motor vehicle and marine (Great Lakes and Northern Resupply). As chairman of the Ad Hoc Rates Committee and of the Sub Committee on Data, he advised on the drafting of the Western Grain Transportation Act and represented the CTC on the Steering Committee overseeing Transport Canada's review of the Atlantic Region Freight Assistance program. He also managed and conducted studies into various aspects of Canadian transportation flowing from initiatives agreed upon at the Western Economic Opportunities Conference, as well as the relationship between transportation and various Canadian industries. This followed a nine-year career in the marketing and sales department of CP Rail.

Captain Randolph Helland, USCG (ret.)

Captain Helland held senior executive positions over a 32-year U.S. Coast Guard career at the national, regional and local levels in the areas of marine/port safety, security, environmental protection and waterways management. Specific positions he held during his Coast Guard career included Chief, Marine Safety, Security and Environmental Protection for the Ninth Coast Guard District (Great Lakes), Captain of the Port, Detroit, MI, Co-Chair Regional Response Team for Region V (Great Lakes), and Co-Chair of the U.S./Canadian Joint Response Team. After his Coast Guard career, he has consulted for companies conducting Port Vulnerability Assessments, Trade Resumption/Business Continuity plans, and marine safety and navigation projects around the U.S.

Captain John Greenway

Captain Greenway attained his Master's certification and command experience on Great Lakes and East Coast Canadian ships. After a 12-year sailing career, he held various marine management positions with Upper Lakes Shipping (Hull – Superintendent, Fleet Superintendent – Operations, and General Manager- Operations). From 2004 to 2010, he served as Vice President – Operations with Seaway Marine Transport and retired in 2011. His involvement in marine regulatory matters has included industry representation with Transport Canada Marine Safety, the Canadian Coast Guard, the Great Lakes Pilotage Authority, the Laurentian Pilotage Authority and the Atlantic Pilotage Authority. Captain Greenway is a recipient of the Transport Canada "Marine Safety Award" which recognized his contribution to marine safety in Canada as well as a recipient of Georgian College's Governors Award for his contribution to marine training in Ontario and to the Canadian marine industry.

Acknowledgments

The study, *Safety Profile of the Great Lakes-St. Lawrence Seaway System*, was commissioned and produced in collaboration with the Chamber of Marine Commerce.

To our knowledge, this is the first time that the safety framework and safety performance has been documented and reported across the entire bi-national Great Lakes-St. Lawrence Seaway System. This report provides a comprehensive account of the key elements of the safety framework currently in place throughout the bi-national navigation system — from regulations and the role of government, vessel construction and inspection, and mariner training — to shipowner and workplace safety programs, advanced navigation technology and emergency response capabilities.

The report also provides the navigation community, transportation planners, government policy makers and the general public with a statistical assessment of the safety performance and spills record of vessels operating in these waters.

The authors would like to thank the Chamber of Marine Commerce, the St. Lawrence Seaway Corporations and the marine carriers for providing valuable input and operating data in the preparation of this report.

We commend the Great Lakes-Seaway marine industry for their efforts to provide this safety profile that builds on prior works to benchmark the marine industry's environmental performance and quantify its economic impacts.

Gordon English
Partner, Research and Traffic Group

David C. Hackston
Partner, Research and Traffic Group

Executive Summary

The Great Lakes and St. Lawrence River together form a critical path for the flow of commerce and essential raw materials for North America's manufacturing and agriculture centers. Ships have been transporting goods along the Lakes and their connecting tributaries for more than two centuries and the maritime industry has played an integral role in the economic and social development of the region.

Over the years, the waterway has evolved. The Welland Canal connected Lake Ontario and Lake Erie, enabling vessels to bypass Niagara Falls. The Soo Locks connected Lake Superior with Lake Huron and the St. Lawrence Seaway allowed vessels to sail from Lake Ontario to the Atlantic Ocean.

Figure ES1. **Great Lakes-St. Lawrence Seaway System**

The resulting navigation system — the longest inland, deep-draft marine highway in the world — supports the activities of more than 100 ports and commercial docks. American and Canadian domestic ships and international ocean-going vessels carry more than 160 million tons of cargo via the waterway each year. This activity generates $35 billion in business revenues and supports 227,000 jobs in Canada and the U.S.[1]

While this economic contribution is vital to the prosperity of the region, the marine shipping industry recognizes that it must be balanced against the protection of people, property and the environment. This waterway is a precious resource that is shared among many. It is the largest freshwater body in the world; a source of drinking water for 40 million people, and a recreational playground for nature and fishing enthusiasts, boaters, tourists and cottage owners alike. It is also uniquely shared by two nations, and regulated and protected by international treaties (such as the *Boundary Waters Treaty* of 1909), U.S.-Canadian binational commissions (such as the International Joint Commission, which regulates water uses and environmental issues), and two federal, two provincial and eight state governments.

Against this backdrop, it is not surprising that an innovative and multi-layered safety regime for the Great Lakes-St. Lawrence Seaway System (**Great Lakes-Seaway**) has developed that builds on the standards in place for international waters.

This report, for the first time, measures safety performance across the entire bi-national Great Lakes-Seaway. It provides a comprehensive account of the bi-national safety framework currently in place throughout the navigation system — from regulations and the role of government, vessel construction and inspection, and mariner training — to shipowner and workplace safety programs, advanced navigation technology and emergency response capabilities.

It also provides the navigation community, transportation planners, government policy makers and the general public with a statistical assessment of the safety and environmental performance and spills record of vessels operating in these waters.

1 Source: The Economic Impacts of the Great Lakes-St. Lawrence Seaway System, Martin Associates, October 2011

Key Elements of the Marine Safety Framework

1. *Government regulation is extensive*

- Due to its bi-national nature, the Great Lakes-Seaway is unlike any other waterway system in the world. The safety regime is anchored by a comprehensive structure of regulations that begins with a well-established international framework for the governance of vessel design and operations led by the International Maritime Organization (IMO). Canadian and U.S. agencies monitor and enforce these standards for any vessel entering their territorial waters and adopt or adapt these regulations for their own domestic fleets. Transport Canada and the U.S. Coast Guard (USCG) are the principal agencies in each country charged with this task.
- While Transport Canada and the USCG are the core safety agencies, there are an additional 18 federal agencies as well as state/provincial and local governments in the two nations involved in various aspects of marine safety.
- The administration of the St. Lawrence Seaway's infrastructure is shared by two entities: the Saint Lawrence Seaway Development Corporation (SLSDC) in the U.S. — a federal agency within the U.S. Department of Transportation — and the St. Lawrence Seaway Management Corporation (SLSMC) in Canada — a not-for-profit corporation. The two Seaway Corporations provide the regulatory framework for the inland navigation waterway under their respective jurisdictions, coordinate operational activities, particularly with respect to rules and regulations, and day-to-day operations of 15 locks between Montreal and Lake Erie, provide traffic management to ensure safe vessel transit, manage draft and water navigation conditions, navigation aids, safety, environmental programs, operating dates and trade development programs and provide management of certain land parcels adjoining the Seaway, owned by the U.S. and Canadian federal governments.

2. *Ship regulations are enforced prior to entry into the Great Lakes-Seaway*

- Before a foreign-flag ship even enters North American waters, it submits a "notice-of-arrival" to the Marine Communications and Traffic Service in Halifax, Nova Scotia. The notice-of-arrival provides critical information that includes prior ports of call, destination port, cargo, and crew nationality. This information is then forwarded to the Canadian Coast Guard's (CCG's) Marine Security Operations Centre in Halifax, and further, to a joint Canadian-U.S. inspection team in Montreal and to the Seaway Corporations. If there is anything related to law enforcement or national security, the Royal Canadian Mounted Police and/or Canada's Department of National Defence will decide the appropriate steps to take, including whether to board the vessel.
- Foreign ships that are permitted in Canadian waters and enter the Great Lakes-Seaway are then subject to a series of inspections to ensure compliance with domestic and international laws, and Seaway-specific regulations. Based in Montreal, a joint Canadian and U.S. team, including Transport Canada, the USCG and the Canadian and U.S. Seaway Corporations, inspect vessels to verify safety, security and pollution prevention requirements, as well as ballast water compliance.
- Possible enforcement actions against non-compliant vessels include preventing transit or the delay of cargo operations until the deficiency is corrected; a monetary fine; or depending on the violation, pursuing criminal charges against the vessel owner, captain of the ship or another person in charge.

3. *Ships are tracked by advanced traffic control systems*

- The Great Lakes shipping industry has been proactive in the development and adoption of satellite-navigation technology to improve safety, with the Seaway being the one of the first inland navigation systems to adopt an integrated vessel Automatic Identification System (AIS). Prior to the introduction of mandatory carriage of this modern equipment, Great Lakes operators were utilizing electronic charting, satellite positioning, and ship information-transmission technology. Significant testing in its infancy and advancement of this navigation technology are credited to the pioneering efforts of Great Lakes shipping companies.

- All vessels entering the Great Lakes-Seaway are monitored by vessel traffic control centers stationed throughout the system. Each vessel is required to have AIS technology as part of its navigation equipment. This technology sends out a signal to each of the vessel traffic centers and also shares important "real-time" navigational information with nearby vessels, including the exact location, speed and course of each vessel. Every commercial vessel that transits the Great Lakes-Seaway can then be tracked electronically (through the AIS) when in the specified traffic control zones, and shore stations can communicate with the vessel by voice using Very High Frequency (VHF) radio. In the Seaway, ongoing real-time navigation information is used by vessels, providing key data that increases navigational safety by enabling mariners to proactively make decisions before a vessel reaches a dangerous point in its transit path.

4. Vessel integrity and equipment are inspected during construction and throughout its lifespan

- Throughout its lifespan, a Great Lakes ship is subject to rigorous inspections and certification oversight — in the original design and construction stage, through mandatory annual inspections, and through the "out of water" dry-docking inspections undertaken on a five-year basis for domestic vessels and twice in every five-year period for international vessels. Regular inspection of vessels is performed by Transport Canada or the USCG or delegated to an approved classification society. These classification societies are subject to audit and verification by government authorities to ensure compliance with all standards.

5. Waterway depths and hazards are continuously monitored and managed

- The U.S. Army Corps of Engineers (USACE) ensures the safe passage of vessels in American waters by constructing and maintaining navigation channels and harbors through dredging and regulation of water levels on inland waterways — including 47 deep-draft U.S. ports and 55 shallow-draft harbors. In addition, the USACE surveys the lakes; builds and maintains 104 miles of breakwater; and operates and maintains 20 lock chambers and 20 confined disposal facilities for dredge materials.
- In the Seaway, both Corporations (SLSMC and SLSDC) ensure the safe passage of vessels in their jurisdictional waters by implementing effective maximum vessel draft and speed management.
- The Canadian Hydrographic Service performs surveys of lakes, rivers and channel bottoms in Canadian waters to ensure the accuracy of depths on navigation charts for safe navigation. The CCG has responsibility for dredging and maintaining safe depths in specific identified navigational channels and Canadian ports are responsible for the dredging of their harbors and navigation channels.
- Water levels are monitored in real time by water-level gauges owned and operated in U.S. waters by the National Oceanic and Atmospheric Administration and USACE — and in Canadian waters, by the SLSMC, CCG and the Canadian Hydrographic Service. Water-depth information is made available to the mariner via Internet, telephone and AIS services — to ensure up-to-date and accurate water-level readings that support safe navigation and route planning.

6. The Great Lakes-Seaway is a compulsory pilotage zone

- Under Canadian and U.S. law, any ship entering the navigation system from overseas is required to hire a Canadian or American pilot. Pilots are expert navigators who are familiar with local geography, weather, currents and sailing conditions. The pilot's expertise supplements the captain's expertise to ensure safe navigation.
- U.S. and Canadian domestic ships meet this requirement through demanding USCG licensing programs for U.S. deck officers. Canadian deck officers follow a similar system through the Great Lakes Pilotage Authority's Pilotage Certification Program. Extensive training, examination and assessment of skills, mandatory trips, valid marine officer credentials and rigorous physical examinations all support the knowledge, skills and capabilities of domestic mariners to conduct their pilotage responsibilities.

7. *Mariners receive specialized training and are licensed by government authorities*

- Commercial vessels operating on the Great Lakes-Seaway are under the control of professional mariners that have not only received specialized training, but have also been licensed by government authorities. A ship's captain, for example, will have graduated from an accredited maritime academy or university program, and will have accumulated years of experience and passed a series of written and oral examinations before obtaining a Master's (Captain's) ticket. In the United States, licensing of merchant mariners is the responsibility of the USCG. In Canada, licensing is the responsibility of Transport Canada.
- In Canada and the U.S., becoming certified as a Master takes a minimum of between six and eight years and, given the need for gaining necessary experience, often longer. Following certification, companies will often require Masters to serve on different ship types; conduct a period of sailing with "Training Masters"; complete additional training on simulators for ship handling, pilotage and bridge resource management; and complete other management courses before taking on command of a ship. A "Master-in-Training" often undergoes 6 to 12 months of additional onboard training under Training Masters, with formal assessments documented.

8. *Stringent tanker safety requirements are in place*

- Liquid bulk cargo is transported on the Great Lakes-Seaway by Canadian, American and international vessel operators. Specially designed tank ships (self-propelled tankers) typically transport petroleum products and liquid chemicals. Tank barges (non-powered vessels pulled or pushed by a tug) are typically used to transport asphalt and heavy oil.
- The U.S. and Canadian governments have adopted environmental safety standards for new and existing petroleum-product tankers operating in Canadian or U.S. waters. These standards require that tankers be built to specific double-hulled standards, resulting in a safety separation between the inner cargo compartments and the ship's outer hull of between 1 and 2 metres (3.3 to 6.6 ft.) depending on the deadweight tonnage (DWT) capacity of the tanker.[2]
- All Canadian, American and international tanker ships operating on the Great Lakes-Seaway must be double hulled by January 1, 2015.

9. *Emergency preparedness and response measures are continuously tested and evaluated*

- The Great Lakes-Seaway marine industry works in partnership with federal, state/provincial and local governments to develop contingency plans to be prepared in the event of marine emergencies. These plans are tested through regular emergency preparedness exercises involving vessels, Coast Guards, ports and the St. Lawrence Seaway Corporations.
- All vessels must have on board a detailed emergency plan, containment booms and other equipment to deal with possible spills, as well as agreements with government-approved emergency response contractors to aid in clean-up, if required.
- In the event of a marine oil spill/emergency in Canada or the U.S., the Coast Guard (Canadian or U.S., depending on jurisdiction) is the first in line-of-command for oversight and response at a spill site. The Seaway Corporations, port and infrastructure management agencies (e.g. for spills in harbors or in Seaway locks/channels) notify all relevant responders and offer assistance in whatever way they can provide, including containment if they have local resources. Oil-response organizations are usually the first responders for spills and address containment and recovery activity. They operate under the direction of the responsible party and fall under the jurisdiction of the Coast Guard, which may intervene if necessary.
- The responsible entity (usually a vessel owner) is liable for the costs incurred and generally has indemnity insurance in excess of the minimum required to cover the costs of a major spill. If required, publicly administered Oil Pollution Funds are available in both countries for payment to those incurring damage or containment costs. Recovery of the funds is sought from the responsible entity and/or insurance company after the clean-up operations are completed.
- The Canada-United States Joint Marine Pollution Contingency Plan provides a coordinated system for planning, preparedness and response to harmful-substance incidents in the contiguous waters. The Joint Marine Pollution Contingency Plan and its Geographic Annexes (Area specific plans) augment the national response systems of Canada and the United States by providing a "bridge" between the two systems — ensuring that coordinated planning is accomplished at the local level.

2 The formula for the width of the space is W (in metres) = 0.5 + DWT/20,000 with a minimum space of 1.0 metres and a maximum of 2.0 metres.

Safety Performance of the Great Lakes-Seaway Fleet

1. *Statistical Analysis*

The Great Lakes-Seaway fleet (Canadian, U.S. and international vessels) operates in Canadian and U.S. waters and the combined activity of these vessels can be isolated from that of other regions of the two countries. Marine safety data specific to the Great Lakes-Seaway was, therefore, collected from Canadian and U.S. government sources for the years 2002 to 2011.

Data on marine accidents in Canada are reported to the Canadian Transportation Safety Board (TSB) and in the U.S., to the U.S. Coast Guard (USCG). Marine safety data for Canada was obtained from the TSB Marine Occurrences Database and for the U.S., from the Marine Casualty and Pollution Database held by the National Technical Information Service. The Canadian TSB data were segmented to include only those vessels that were making a trip into the Seaway. Thus, accidents occurring in the lower St. Lawrence River were included only if the vessel had an origin or destination west of Montreal.

The marine reporting requirements include both transportation-related accidents and employee health- and safety-related accidents when occurring aboard vessels. Marine transportation-related accidents include vessel events such as strikings, groundings and collisions. Therefore, the data can be segmented into transportation-related casualties and workplace-related casualties.

Spills in U.S. waters are reported to the USCG and the data are included in the same Marine Casualty and Pollution Database cited above. Spills in Canadian waters are reported to the CCG and a 10-year (2002-2011) history of data was obtained for analysis in this study. Spills were included if they occurred in the Great Lakes-Seaway — which covers the Seaway within Montreal and all Great Lakes-Seaway waters west of Montreal. Much of the activity on the tributary rivers/canal systems involves barges that operate strictly on the rivers and canals. Spills occurring on the tributary rivers, canals and harbors were only included if they involved a Great Lakes bulk cargo vessel or a barge of 2,000 gross registered tonnage (GRT) or higher.

2. *Public Safety Record*

Great Lakes-Seaway ships operating in Canada and the U.S. carried more than 1.5 billion metric tonnes of cargo over the 10-year period (2002 to 2011) without any accidents negatively impacting public safety.

There were a total of 801 reported vessel accidents and safety occurrences throughout the entire system in Canada and the U.S. over the period of 2002 to 2011. Most of the marine accidents were minor in nature with 59% of the accidents reported in U.S. waters resulting in no damage to the vessel and 97.5% of accidents reported in Canadian waters classified at the minimum severity ranking.

Vessel collisions/strikings or groundings (transportation-related accidents) resulted in zero fatalities and injuries to members of the public. Shipping accidents did result in two injuries to marine employees. Based on the total number of vessels trips made over the 10-year data interval, 100% of trips were fatality-free and 99.997% were injury free in relation to shipping accidents.

The analysis shows that the rate of transportation-related injuries per 100-billion tonne-km for marine vessels in this region is 17 times lower than the national rate for Canadian freight railways and 70 times lower than U.S. Class 1 freight railways. The rail statistics include casualties due to train derailments/collisions, highway grade crossing collisions and trespass collisions.

Table ES1. **Comparison of Marine and Rail Injury and Fatality Rates for Transportation-related Accidents (2002-2011)**

Mode	Injuries	Fatalities
Rate per 100-billion tonne-km		
Marine – Great Lakes-Seaway Vessels	0.10	0
Rail – Cdn Freight Railways	1.78	0.64
Rail – U.S. Class 1 Freight Railways	7.0	0.65
Rate per 100-billion ton-miles		
Marine – Great Lakes-Seaway Vessels	0.15	0
Rail – Cdn Freight Railways	2.59	0.94
Rail – U.S. Class 1 Freight Railways	10.2	0.95

Source: RTG analysis of Canadian TSB accident data and Federal Railway Administration casualty database and ton-mile data from the U.S. Department of Transport, Bureau of Transportation Statistics, Appendix D: Rail Profile.

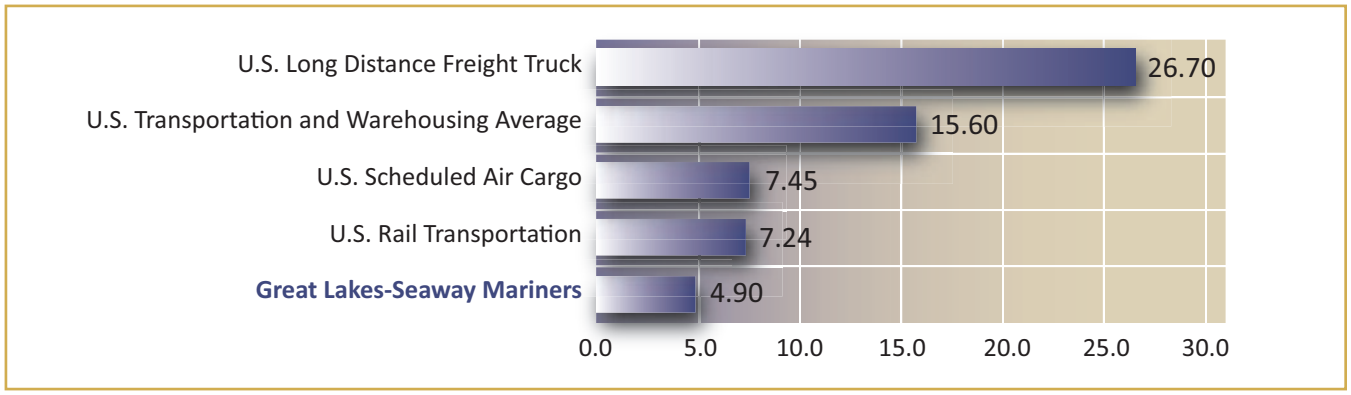
3. *Workplace Safety Record*

For the 10-year period of 2002 to 2011, a total of 5 employee fatalities occurred while onboard vessels - 2 aboard Canadian-flagged vessels and 3 aboard U.S.-flagged vessels.

Analysis of Canadian and U.S. government records shows that Great Lakes-Seaway mariners have significantly lower employee fatality rates than other U.S. transportation and material-moving occupations, including rail, trucking and air cargo sectors. Over the 10-year period 2002-2011, employee fatality rates were about 50% higher for rail transportation and 5.5 times higher for long-distance trucking compared to Great Lakes-Seaway mariners.

A similar workplace safety comparison against other Canadian freight modes was not possible due to a lack of consistent and comparable government information.

Figure ES2. **Freight Transport Mode Employee Fatality Rates Per 100,000 workers (2002-2011)**



Source: Fatality rates based on census data published by the U.S. Department of Labor, Bureau of Labor Statistics, Census of Fatal Occupational Injuries (2002-2011)

Note 1: Marine casualties are those of the combined U.S. and Canadian waters of the Great Lakes-Seaway based on USCG and TSB data.

Note 2: Employee workplace fatalities exclude 3 fatalities resulting from previously existing medical conditions that are reported in the marine data but are not included in the chart as they are not "workplace casualties" as defined in normal labor statistics.

4. *Spills in Canadian and U.S. Waters*

Spills of dangerous goods in Canada and hazardous materials in the U.S. are reported to the respective Coast Guards. Analysis of the data shows that there were 139 releases from vessels in the bi-national Great Lakes-Seaway, over the period of 2002 to 2011.

Spills were predominantly small product spills during loading/unloading, or minor releases of consumables such as hydraulic fluid, lubricating oil or fuel oils. The data include bulk and general cargo vessels, as well as tank ships and barges. None of the marine releases resulted in casualties.

Table ES2. **Dangerous Goods/Hazardous Materials Spills Performance of Great Lakes-Seaway Fleet (2002-2011)**

	Canada	U.S.	Total	Avg/Year
Spills Reported	**73**	**66**	**139**	**14**
Quantity – Litres	20,291	17,165	37,456	3,746
Quantity – U.S. gallons	5,361	4,534	9,895	990

Source: Derived from USCG Marine Casualty and Pollution Database and TSB Marine Occurrences Database

Based on an estimated 69,960 vessels trips made over the 10-year data interval, 99.8% of vessel trips were "incident-free" — in terms of releases of dangerous goods/hazardous materials.

The spill-free performance of all tank vessels and barges operating in the Great Lakes-Seaway was 99.99% for the 10-year period of 2002-2011.

For the period of 2002-2011, the quantity of spills occurring on tank vessels and barges (i.e. during loading or unloading operations, or minor releases of consumables) totaled 9,574 litres (2,522 U.S. gallons) in Canadian waters and 4,046 litres (1,071 U.S. gallons) in U.S. waters. The combined spill rate is equivalent to 157 millilitres (about 10.5 tablespoons) per million litres of product carried —or 2.5 cups for every million U.S. gallons carried.

On an annual basis, the quantity of spills occurring on tank vessels in Canadian and U.S. waters was 1,362 litres (360 U.S. gallons) per year. This annual amount is equivalent to 1.2% of the capacity of a single rail tank car (i.e. 113,000 litres/30,000 U.S. gallons).

Closing Comments from the Study Authors

It is clear from our analysis that the Great Lakes-Seaway marine system operates under a well-established safety framework, has coordinated bi-national response programs/procedures in place and over the past decade, its operators have demonstrated an exemplary safety record. Great Lakes-Seaway overseers and operators have shown initiative in developing safety training programs and leadership in testing/adopting new technology. In benchmarking with other modes, the Canadian, U.S. and international vessels operating on the Great Lakes-Seaway were found to exceed the safety performance of other freight transport modes, in both safe transportation and employee workplace safety. In every area that benchmarking data were available, Great Lakes-Seaway operators essentially set a safety-performance benchmark that other modes could strive to attain.

Gord English, Partner

David Hackston, Partner

Research and Traffic Group

The full report of the Safety Profile of the Great Lakes-St. Lawrence Seaway System follows or is available on www.marinedelivers.com and provides a more detailed account of the safety framework in place, as well as a breakdown of safety performance data by country.

Introduction

The focus of this study is the safety profile of the commercial shipping industry and of its operations on the Great Lakes-St. Lawrence Seaway System (**Great Lakes-Seaway**). Shipping activity on the system involves significant elements of Canadian and U.S. domestic and cross-border trade, as well as international shipments to and from inland ports on both sides of the border.

The Great Lakes cover approximately 94,000 square miles (243,460 square kilometers) and hold an estimated 6 quadrillion (10^{15}) gallons (22.7 quadrillion litres) of water, about one-fifth of the world's supply of surface fresh water. Completing the Great Lakes system are the St. Lawrence River and Seaway, connecting the lakes to the Atlantic Ocean and providing inland navigation to ocean vessels.

The Great Lakes-Seaway stretches from the Gulf of St. Lawrence to the Lakehead (Duluth/Thunder Bay), a distance of 2,300 miles (3,700 kilometers) (see **Figure 1**). It includes the five Great Lakes, as well as the St. Lawrence River to the Gulf of St. Lawrence. The Great Lakes-Seaway is a bi-national waterway bordering on two Canadian provinces and eight states in the United States.

This safety profile provides a comprehensive portrait of the regulatory framework and the role of government with respect to marine safety and specific elements related to the Great Lakes-Seaway. The report also provides a summary of the key safety management practices in the marine sector, including navigational safety, training and certification of mariners, and workplace safety on vessels and landside marine facilities, as well as the marine sector's emergency preparedness and response regimes.

Figure 1. Map of the Great Lakes-St. Lawrence Seaway System

Key Elements of the Marine Safety Framework

1 Regulatory Framework and Role of Government

1.1 Overview

The marine mode dominates international freight transport and, as a consequence, has a well-established international framework for the governance of vessel design and operations. International agreements/ standards, including those from the International Maritime Organization (IMO), are a fundamental part of the maritime regulatory framework of Canada and the United States. Since its inception, the IMO has established numerous conventions, standards and codes directed at the safety of vessels and crews. Canadian and U.S. agencies monitor and enforce these standards for any vessel entering Canadian or U.S. waters. In addition, due to their unique service, most vessels that trade exclusively on the Great Lakes follow domestic regulations that are generally based on IMO regulations but adapted to reflect the operating environment and conditions of the lakes.

Regulatory agencies develop and maintain standards, rules, regulations and guidance for the maritime industry regarding personnel qualifications, including human factors (Crew Endurance Management), organizational issues (risk management), security, and environmental protection standards.

Transport Canada is the principal agency charged with ensuring that Canadian- and foreign- flagged vessels comply with domestic and international safety and security regulations. In the U.S., the U.S. Coast Guard (USCG) generally has authority for marine safety regulations, homeland security, maritime law enforcement, search and rescue, marine environmental protection, icebreaking and the maintenance of aids to navigation.

Administration of the Seaway's infrastructure is shared by two entities: the Saint Lawrence Seaway Development Corporation (SLSDC) in the U.S. — a federal agency within the U.S. Department of Transportation — and the St. Lawrence Seaway Management Corporation (SLSMC) in Canada — a not-for-profit corporation. The mission of both Seaway Corporations is to provide a safe and efficient marine transportation system within the St. Lawrence Seaway.

While the above are the core safety agencies, many federal agencies and all levels of government are involved in aspects of marine safety. **Figure 2** summarizes the roles of the various agencies and governments involved in marine safety in the Great Lakes-Seaway.

Figure 2. **Governmental Participation by Functional Area**

	Functional Areas of Safety Responsibility/Participation									
Agencies	*Ship Safety*	*Port/ Facility*	*Emergency Response*	*Aids to Navigation*	*Ice Breaking*	*Dredging/ Water Levels*	*Environment*	*Mariner Safety/ Health*	*Licencing/ Pilotage*	*Other*
Canadian Agencies										
Transport Canada	X	X	X			X	X		X	
Canadian Coast Guard			X	X	X	X	X			X
Canadian Border Services Agency										X
Canadian Hydrographic Services										X
Department of National Defence										X
Environment Canada			X				X			X
Human Resources and Skills Development								X		
Labour Canada		X						X		
St. Lawrence Seaway Management Corp.	X	X	X				X			
Transportation Safety Board	X							X		
Provincial Governments		X	X				X			
Local Governments		X	X				X			
U.S. Agencies										
U.S. Coast Guard	X	X	X	X	X		X	X	X	
Army Corps of Engineers		X				X	X			
Centers for Disease Control and Prevention								X		
Customs and Border Protection	X									
Department of Agriculture										X
Department of Labor								X		
Environmental Protection Agency			X				X			
Federal Communications Commission										X
National Oceanic and Atmospheric Administration						X				X
Saint Lawrence Seaway Development Corp	X	X	X				X			
State Governments		X	X				X			
Local Governments		X	X				X			

1.2 International Regulatory Framework

Many Canadian and U.S. marine safety and environmental standards originate from the IMO, which was formally established in 1948 at an international conference in Geneva. The purposes of the IMO, as summarized by Article 1(a) of the Convention, are *"...to provide machinery for cooperation among Governments in the field of governmental regulation and practices relating to technical matters of all kinds affecting shipping engaged in international trade; to encourage and facilitate the general adoption of the highest practicable standards in matters concerning maritime safety, efficiency of navigation and prevention and control of marine pollution from ships."*

As member countries of the IMO, Canada and the U.S. participate in the development of these international standards, which all member countries have agreed to apply uniformly to ocean-going vessels. As noted later in greater detail in this report, Canadian and U.S. agencies monitor and enforce these standards for any vessel entering Canadian or U.S. waters.

Since its inception, the IMO has established numerous conventions, standards and codes. Examples include: *International Convention for the Prevention of Pollution from Ships*; *International Convention on Standards of Training, Certification and Watchkeeping*; *International Convention on Certification of Seafarers*; *International Safety Management Code Program*; and *International Ship and Port Security Code*.

1.3 Domestic Regulatory Framework

Canadian and U.S. regulatory agencies are responsible for developing and promulgating national regulations and standards that govern the safe design and construction of ships and shipboard equipment — including hull structure, stability, electrical and mechanical systems, lifesaving and fire safety equipment — and related equipment approval and laboratory acceptance. A regulatory framework has been established to develop and maintain standards, regulations and industry guidance for vessel and facility operations. Additionally, regulatory agencies develop and maintain standards, rules, regulations and guidance for the maritime industry regarding personnel qualifications, including human factors (Crew Endurance Management), organizational issues (risk management), security, environmental protection standards, and oil-spill preparedness and response programs.

Canadian and U.S. regulatory agencies adopt the international conventions via regulations or standards for their domestic fleets. However, modifications are sometimes made in recognition of the different operating environments. Ocean-going vessels face different conditions than the domestic fleets confined to inland waters such as the Great Lakes-Seaway — creating the need to adapt international standards to meet domestic water needs. Also, ocean-going vessels operate at significant distances from emergency response facilities, unlike local operations on the Great Lakes and their proximity to shore assistance.

The process for adapting international standards or developing new domestic standards is similar for both countries; it includes input and collaboration from the maritime industry and other stakeholders through established committees and forums. In Canada, the national and regional Canadian Marine Advisory Council is a consultative body for marine matters — providing input in the development and implementation of national statutes, regulations, codes, standards, recommendations and procedures, operations and services. In the U.S., a number of committees provide the same function. The National Maritime Security Advisory Committee, the Merchant Marine Personnel Advisory Committee and other safety committees that deal with specific aspects of the marine industry (fishing, hazardous materials, environmental, etc.) are nationally recognized and form a government/industry partnership in addressing specific regulatory issues.

1.3.1 Canada

In Canada, Transport Canada is the principal agency charged with ensuring that Canadian and foreign-flagged vessels comply with domestic and international regulations pertaining to safety, pollution prevention and security. Transport Canada has a central office in Ottawa, and regional offices and staff located across Canada. Coverage on the Great Lakes and Seaway includes offices in the key port areas of Thunder Bay, Sarnia, St. Catharines, Toronto, Kingston and Montreal. Areas of responsibility include: vessel standards and compliance; registration and licensing of pleasure craft and operators; dangerous goods container inspections; navigation and communications; and ship operations and inspections.

Transport Canada's roles also include maintaining industry stakeholder relationships through the Canadian Marine Advisory Council; overall responsibility for marine security; all matters relating to marine personnel, training and certification; and the maintenance and governance of the *Canada Shipping Act* and all related marine regulations. Responsibility for environmental compliance standards is shared by Transport Canada, the Canadian Coast Guard (CCG) and Environment Canada.

Other Canadian federal government agencies with a safety-related involvement of a regulatory or support nature include:

- Canadian Coast Guard (aids to navigation, ice breaking, and search and rescue);
- Canadian Border Services Agency (Customs, immigration, and border security);
- Canadian Hydrographic Services (navigation products and services);
- Department of National Defence (search and rescue support);
- Environment Canada (pollution response, weather services);
- Human Resources and Skills Development (health and safety);
- Labour Canada (workplace health and safety);
- Transportation Safety Board (accident investigation and safety recommendations).

1.3.2 United States

Headquartered in Washington, D.C., the USCG has a broad mandate that includes serving as the "regulator of maritime affairs" on behalf of the U.S. government and the public. In addition, the USCG has roles in homeland security, maritime law enforcement, search and rescue, marine environmental protection, icebreaking and the maintenance of aids to navigation. The USCG is one of the "armed forces" of the United States, with extensive roles in maritime safety, security and stewardship.

Further defined, the USCG "missions" fall under either homeland security or non-homeland security criteria. Homeland security includes: defense readiness, maritime law enforcement, and drug and migrant interdiction, as well as ports, waterways and coastal security. Non-homeland security includes: ice operations, living marine resources (fisheries law enforcement), marine environmental protection, marine safety, aids to navigation, and search and rescue.

The USCG is divided into Coast Guard Districts throughout the United States — with the Great Lakes and Seaway under the Ninth Coast Guard District, headquartered in Cleveland, Ohio. Marine safety and search and rescue offices and resources are located throughout the Lakes, including "Captain of the Port" areas of sector responsibility in Sault Ste. Marie, Milwaukee, Detroit and Buffalo.

Other U.S. federal agencies that play a regulatory or support role related to maritime safety affairs include:

- Army Corps of Engineers (harbor and waterway construction/maintenance);
- Centers for Disease Control and Prevention (health issues);
- Customs and Border Protection (vessel inspection and security clearance);
- Department of Agriculture (animal and plant health inspection);
- Department of Labor (workplace safety and health);
- Environmental Protection Agency (pollution and emergency response);
- Federal Communications Commission (maritime satellite communications);
- National Oceanic and Atmospheric Administration (navigation charts and weather services).

1.3.3 Joint Canada/U.S. Activities

The Great Lakes-Seaway is unlike any other waterway system in the world. The Seaway was built as a bi-national partnership between the U.S. and Canada, and continues to operate as such. Administration of the Seaway's infrastructure is shared by two entities: the SLSDC in the U.S. — a federal agency within the U.S. Department of Transportation — and the SLSMC in Canada — a not-for-profit corporation. Ownership of the Canadian portion of the Seaway remains with the Canadian federal government. The mission of the Seaway Corporations is to provide a safe and efficient marine transportation system. The two Seaway entities coordinate operational activities, particularly with respect to rules and regulations, day-to-day operations of 15 locks between Montreal and Lake Erie, traffic management, navigation aids, safety, environmental programs, operating dates and trade development programs.

1.4 Other Roles of Government

1.4.1 Communications and Monitoring

Monitoring the location and assessing the status of any vessel that enters the Great Lakes-Seaway are critical. Equally critical is the communication of important information to the appropriate governmental organizations. The Great Lakes-Seaway has a system in place whereby bi-national decisions are made even before a foreign-flagged vessel reaches the territorial waters of Canada.

The communications and monitoring process starts when a foreign-flagged vessel is well out in the Atlantic Ocean and submits a "notice-of-arrival" to the Marine Communications and Traffic Service in Halifax, Nova Scotia. The notice-of-arrival provides critical information that includes prior ports of call, destination port, cargo, and crew nationality. This information is then forwarded to the CCG's Marine Security Operations Centre in Halifax, and further, to a joint Canadian-U.S. inspection team in Montreal and to the Seaway management entities. The information is analyzed by a team of officials from Transport Canada, the USCG and the Seaway Corporations. Any law enforcement or national defense issues are passed to law enforcement and/or defense agencies in Canada and the U.S. for analysis and any required follow-up.

The Niagara Region Operations Control Centre is among a number of traffic control centres that monitor vessels travelling throughout the Great Lakes-Seaway.

The bi-national team then decides whether to take any action. If there is anything related to law enforcement or national security, the Royal Canadian Mounted Police and/or Canada's Department of National Defence will decide the appropriate steps to take. If enforcement action is deemed necessary, the vessel will most likely be boarded at sea by one of the law enforcement or national security agencies. Decisions related to conducting a routine safety, security and environmental-compliance inspection at Montreal will be made by Transport Canada, the USCG and the two Seaway Corporations.

1.4.2 Vessel Screening/Tracking

Vessels granted entry and passing inspection are monitored on the Great Lakes-Seaway by a number of government-operated vessel traffic-control centers. The U.S. Seaway's vessel traffic center is in Massena, New York, and the Canadian Seaway's vessel traffic centers are in St. Catharines, Ontario for the Welland Canal and Great Lakes (Ontario and Erie) sectors, and in Montreal for the St. Lawrence River sector. The CCG's Marine Communication and Traffic Service in Sarnia, Ontario covers the western portion of Lake Erie through the Detroit and St. Clair Rivers up into Lake Huron, and the USCG's Vessel Traffic System Center in Sault Ste. Marie, Michigan, covers Lake Huron, the St. Marys River and into Lake Superior. Other U.S. and Canadian Coast Guard stations have radio/telephone equipment that enables communication with commercial and non-commercial vessels that are navigating outside of the vessel traffic systems previously described.

Each vessel is required to use an Automated Identification System (AIS) as part of its navigation equipment. An AIS sends out a signal to each of the vessel traffic centers and shares important navigation details between vessels, including the exact location, speed and course of each vessel. Every commercial vessel that transits the Great Lakes-Seaway can then be tracked electronically (through the AIS) when in the specified traffic control zones, and shore stations can communicate with the vessel by voice using Very High Frequency (VHF) radio.

1.4.3 Enforcement and Compliance

Ships entering the Great Lakes-Seaway are subject to a series of inspections to ensure compliance with domestic and international laws. Historically, all vessels were inspected by the SLSDC and the SLSMC in Montreal, to ensure that they were in compliance with Seaway safety regulations including: equipment for transiting the locks; navigation equipment (and associate navigation charts and publications); environmental standards (including ballast water requirements); and pilotage requirements. After the September 2001 terrorist attacks in the U.S. and the implementation of the *International Ship and Port Security Code*, additional security requirements were placed on vessels prior to entering the Great Lakes-Seaway.

Starting in 2002, a joint Canadian and U.S. team was established in Montreal to conduct all safety, security and environmental compliance inspections on foreign-flagged vessels, prior to their entry into the St. Lawrence Seaway. Four organizations — Transport Canada; the USCG; and the Canadian and U. S. Seaway Corporations — co-ordinate their activities in a bi-national effort to ensure the safety, security and environmental compliance of commercial vessels entering the system. Vessels are inspected for compliance with Seaway requirements, international and domestic safety regulations (Port State Control), as well as verification of ballast water and other requirements for pollution prevention and for security. This process allows for a seamless flow of information between bi-national regulatory agencies, and ensures that the screening and inspection of each vessel is conducted efficiently and thoroughly before it reaches the internal waters of either country.[3]

Enforcement is commonly achieved through education and partnership to achieve compliance; however, some cases require more punitive measures. A vessel found to be non-compliant with any of the foregoing requirements could be subject to a number of actions, based on evaluation by the respective governmental agency. Options for enforcement include preventing the transit of the vessel or the delay of cargo operations until the deficiency is corrected. All deficiencies must be corrected to the satisfaction of the governmental agency responsible for the specific area of concern. A civil penalty in the form of a monetary fine is another option. Monetary penalties will vary, depending on the type of violation, the duration, and the laws and regulations of the agency. There are rare cases that can warrant criminal sanctions against owners, operators or ships' crews, which are available to both governments if necessary.

3 The USCG and Seaway Corporations have reported that: "The Enhanced Seaway Inspection Program inspect 100% of ocean vessels during their first Seaway inbound transit at Montreal, Quebec…the goal was achieved during the 2010 season (and in all subsequent years) with 245 vessel inspections conducted." (Seaway Audit, 2012)

2 Marine Navigational Safety

2.1 Vessel Construction and Inspections

Great Lakes ships, which operate in fresh water, can be maintained in a safe operational state for many years — extending to 50 years and beyond. Some of the Great Lakes fleet is being renewed on economic grounds — as newer vessels receive enhancements in areas such as speed, fuel efficiency, cargo-carriage capacity and environmental performance. Other ships will continue to operate with ongoing maintenance, upgrades and refurbishments.

Ongoing inspections are a key factor in determining the structural condition and planned maintenance cycle for a ship. Throughout its lifespan, a ship is subject to rigorous inspections and certification oversight — in the original design and construction stage, through mandatory annual inspections, and through the "out of water" dry-docking inspections undertaken on a five-year basis.

2.1.1 Role of Classification Societies

Vessel inspections (or surveys[4]) are usually completed by "recognized organizations" known as classification societies, with involvement and verification by representatives of the flag state (i.e. the country of registry of the vessel, which is Transport Canada for Canadian-flagged vessels and the U.S. Coast Guard (USCG) for U.S.-flagged vessels).

A classification society is a non-governmental organization that establishes and maintains technical standards for the construction and operation of ships and other offshore marine structures, and for non-marine industrial entities. Each classification society also operates independently and may be recognized internationally and domestically by government authorities. It also validates that the construction of a ship is in accordance with these standards, and carries out regular surveys/inspections during a vessel's service life to ensure continued compliance. Classification societies are considered to be impartial and to have technical expertise within their scope of survey services.

Historically, classification societies date from the 18th century and their umbrella association — the International Association of Classification Societies (IACS) — provides oversight and governance of standards, harmonizes rules and inspections, and sets levels of quality performance among the classification societies.

Worldwide, classification societies have common stated objectives of supporting maritime safety and pollution prevention, and undertake activities in the following areas:

- Promotion of safety of life, property and the environment;
- Development of technical standards (rules) for the design and construction of ships;
- Approval of ship designs against their standards;
- Conducting ship surveys during construction to verify the ship is built in accordance with the approved design and rule requirements;
- Acting as a "recognized organization" by maritime administrations to carry out delegated surveys and certification;
- Developing regulations for, and undertaking in-service inspections and periodic ship surveys during operations;
- Conducting research and development programs; and
- Providing technical support to international organizations such as the International Maritime Organization (IMO), the International Organization for Standardization (ISO) and the IACS.

4 "Surveying" is a term used for the inspection of a vessel. Surveying can be done for a number of purposes (e.g. a safety survey, loadline survey, radio inspection survey), which are all related to inspections for the purposes of verifying the ship to standards and criteria for the issuance of certificates. Other surveys include insurance surveys (Protection & Indemnity Condition Survey, for example), and cargo surveys (to determine the condition of cargo, or to determine and verify the amount of cargo on board, through a cargo deadweight survey). Inspectors with regulatory authorities or with classification societies are often referred to as "marine surveyors."

A vessel is "classed" when it is under the inspection regime of a classification society. The classification society accepts the vessel into its "class" and verifies that it is built, equipped and operating to the standards and criteria set for the type of vessel and its geographic area of trade. Classing a ship involves inspection and verification of the structural strength and integrity of essential parts of the ship's hull and machinery, and the reliability and functionality of the propulsion system, steering systems, power generation systems and other auxiliary systems fitted on the ship to maintain services and operations.

2.1.2 Government Oversight and Delegation of Inspections

Transport Canada and the USCG have alternative inspection programs under which authority for survey and inspection of ships is "delegated" to an "approved" classification society. Transport Canada's Delegated Ship Inspection Program and the USCG's Alternate Compliance Program operate in a similar fashion. Strict criteria and standards are set for both the ship and the classification society undertaking the inspection responsibilities, and the programs are subject to audit and verification by the respective government authorities to ensure compliance with all standards of the programs.

A ship owner's/operator's use of inspectors in the alternative inspection programs, instead of government inspectors, is optional. The vast majority of commercial ships are surveyed for compliance with "rules" as set by classification societies. Some smaller vessels, such as tugs, barges and passenger vessels, may choose not to use a classification society, thereby remaining solely under flag-state inspection authority (i.e. Transport Canada or the USCG) with similar rules, regulations and standards.

The delegated inspection programs maintain marine safety, while increasing efficiency and eliminating service duplication related to inspections and surveys. Monitoring programs conducted by Transport Canada and the USCG are developed to verify the competence and diligence of the "delegated classification society" and ensure that the ships covered by the society remain in compliance with all rules, regulations and standards applicable to the ship and trade.

Transport Canada and the USCG have alternative inspection programs under which authority for survey and inspection of ships is delegated to an approved classification society.

Canadian domestic vessels operating on the Great Lakes are primarily classed by two major classification societies — Lloyds Register of Shipping and Det Norske Veritas. Survey and inspection of the U.S. fleet is undertaken primarily by the American Bureau of Shipping.

2.2 Management and Monitoring of Waterway Depth and Hazards

Waterway infrastructure management involves:

- Dredging and/or managing dredging of the Great Lakes-Seaway connecting channel;
- Monitoring commercial channel depth by surveying on a periodic basis to identify the bottom conditions and any restrictions on or hazards related to safe navigation; and
- Providing this information to mariners, pilots and other stakeholders.

Great Lakes waterways management issues are addressed through the Great Lakes Regional Waterways Management Forum, a bi-national government and industry group formed to address bi-national waterways issues on the Great Lakes. The forum is chaired by the USCG with bi-national participation from the regulatory side of Transport Canada, the Canadian Coast Guard (CCG), the U.S. National Oceanic and Atmospheric Administration, and the U.S. Army Corps of Engineers (USACE). Marine industry stakeholders (including shipping associations and companies, port associations and port representatives, environmental interests, recreational boating and local law enforcement agencies) also participate in the forum. Agenda items include navigation safety; dredging and water levels; cargo residue and ballast water management; regulatory harmonization; and overall waterways management.

Waterways infrastructure management in Canada involves dredging, monitoring channel bathymetry and providing this information to mariners, pilots and other stakeholders.

The operation and management of most major Canadian ports have been transitioned to local Canada Port Authorities to ensure continued commercial viability and sustainability. The Port Authorities are responsible for the safe and efficient operation of the ports' infrastructure, including: maintaining harbor depths and navigational channels, dock and port facilities, liaison with private terminals and facilities within the ports' geographic areas, and safety and security. Examples under this structure include the ports of Thunder Bay, Windsor, Hamilton, Toronto, Oshawa and Montreal.

Other Canadian ports are either owned by Transport Canada, local stakeholders or private interests. One example is the Port of Sarnia at the head of the St. Clair River, which is undergoing a transition from Transport Canada ownership to ownership/operation by the local municipality, supported by its port stakeholders. Another example is Nanticoke on Lake Erie, which is owned, maintained and operated by private interests related to the industries/facilities of the area.

The operation of U.S. ports on the Great Lakes varies from independently owned and operated to public ports that are independently operated but owned by state or county government. In many instances, public ports were created by state or local statute with the primary aim of enhancing marine commerce. In addition to their activities relating to maritime commerce, many port authorities manage and develop property, operate airports, sponsor development financing, and manage environmental projects. U.S. public ports include but are not limited to: the Duluth Seaway Port Authority; Detroit-Wayne County Port Authority; Cleveland-Cuyahoga County Port Authority; Illinois International Port District; and Toledo-Lucas County Port Authority.

The USCG responsibilities for waterways management include, in part: identifying major waterway safety hazards; estimating risk levels; evaluating potential mitigation measures; and implementing selected risk-reduction measures.

The USACE is responsible for facilitating the safe, reliable, economically efficient and environmentally sound movement of vessels. It fulfills this mandate by constructing and maintaining navigation channels and harbors through dredging and regulation of water levels on inland waterways — including 47 deep-draft ports and 55 shallow-draft harbors on the U.S. side of the Great Lakes. In addition to dredging operations, safe operation and maintenance of the 734 miles of Great Lakes navigation channels are made possible by USACE's ongoing activities to map and survey the lakes; build and maintain 150 miles of breakwater; and to operate and maintain 25 lock chambers and 44 confined disposal facilities for dredge materials.

On the Canadian side, the Canadian Hydrographic Service performs surveys of lakes, rivers and channel bottoms to ensure the accuracy of depths on navigation charts for safe navigation. The CCG has responsibility for dredging and maintaining safe depths in specific identified navigational channels.

Water depths are monitored in real time by water-level gauges owned and operated in U.S. waters by the National Oceanic and Atmospheric Administration and USACE — and in Canadian waters, by the CCG and the Canadian Hydrographic Service. Water-depth information is made available to the mariner via Internet, telephone and Automatic Identification System (AIS) services — to ensure up-to-date and accurate water-level readings that support safe navigation and route planning.

2.3 Advanced Navigation Technology

The Great Lakes shipping industry has been proactive in the development and adoption of satellite-navigation technology to improve safety. Prior to the introduction of mandatory carriage of this modern equipment, Great Lakes operators were utilizing electronic charting, satellite positioning, and ship information-transmission technology. Significant testing in its infancy and advancement of this navigation technology are credited to the pioneering efforts of Great Lakes shipping companies.

- **Electronic Charting System (ECS) and Electronic Chart Display and Information System (ECDIS)** provide the ability to utilize official nautical charts[5] in an "intelligent" computerized format and to determine the position of the ship on a real-time basis — on a computerized chart display using satellite Global Positioning System (GPS) technology and/or enhanced differential GPS. The two charting systems reduce the risk of human error in navigation and pilotage; enhance safety during periods of reduced visibility; provide real-time route position monitoring; and increase overall navigational safety in the confined waters of the Great Lakes. The ECS was quickly adopted by Canadian and U.S. mariners — with the first testing by Great Lakes ship operators beginning in 1991-92 and ships being fitted with this equipment in 1994-95. For many years, this equipment has been standard fitted navigational equipment onboard the majority of Great Lakes domestic ships.[6]

- **Automatic Identification System (AIS)** uses satellite GPS and an AIS transponder to transmit the vessel's exact location, speed and course among other items of useful data, to other ships similarly fitted, and to the Vessel Traffic Services of the St. Lawrence Seaway and the Canadian and U.S. Coast Guards.

  This shipboard broadcast system operates in the Very High Frequency (VHF) maritime band and is capable of handling well over 4,500 reports per minute, and provides updates as frequently as every two seconds. It ensures reliable ship-to-ship operation. Collected AIS data improve the safety of vessels and ports through collision avoidance — and the safety of the nation through detection, identification and classification of vessels, with information provided through up-to-date data. This information provides ships passing each other with critical safety information to ensure safe navigation, and provides the Vessel Traffic Services of the Canadian and U.S. Coast Guards with monitoring knowledge of vessels in the system.

  The Seaway has taken this technology further by also utilizing AIS to relay safety information such as wind speed and direction, water-level information, ice conditions, lock dispatches and safety-related messages. The result is a tightly integrated navigation aid that enhances the ability of each ship captain and/or pilot to navigate the Seaway safely and efficiently. The Seaway AIS System, originally funded and supported by the marine shipping stakeholders, became operational in 2002 and mandatory in 2003.

- **Seaway Draft Information** is navigation information published through a number of mechanisms: AIS, *Seaway Notices*, *Radio Notices* and *Notices to Shipping*. *Seaway Notices* address issues specific to a given navigation season and serve to complement the regulations found in the *Seaway Handbook*. The notices — which take the form of general notices applicable to the entire St. Lawrence Seaway, and regional notices that may be applicable to the Montreal/Lake Ontario region or to the Welland Canal — are disseminated via e-mail broadcasts to subscribers.

  Up-to-date and accurate water-level information relevant to mariners is provided via Internet, telephone and AIS by the National Oceanic and Atmospheric Administration and CCG monitoring equipment. This information on water levels is critical to safety — particularly in the channels and rivers connecting the Great Lakes.

5 Canadian Hydrographic Service charts and U.S. National Oceanic and Atmospheric Administration charts.
6 The Canadian Shipowners Association reported its entire members' fleets being fitted with ECDIS by 1997 (Grant & Goodyear, *ECDIS: Past, Present and Future*).

- **3-D and Draft Optimizer Equipment** is in active development among Great Lakes-Seaway ship operators. Vessels operating in shallow waters are subject to down-draft forces, called squat[7], which reduces the effective draft available. The new draft optimizer technology, initiated and led by the marine industry, enhances the ECS by taking real-time ship's speed and position, incorporating the latest detailed and accurate charting survey information, and performing complex squat calculations to provide a "safe look ahead" in shallow areas. The optimization system is being designed to perform these down-draft calculations and provides navigators with real-time information to ensure safe ship speeds and safer navigation, particularly in low water levels.

  The Seaway has incorporated standards and inspection processes to verify the functionality and performance of fitted equipment. The Seaway is also testing the viability of having vessels utilize this modern technology to operate at deeper drafts in certain segments of the Seaway.

New 3D and Draft Optimizer equipment takes real-time ship's speed and position, the latest charting survey information, and performs complex calculations to provide a "safe look ahead" in shallow areas.

2.4 Aids to Navigation

The USCG manages a total of 2,645 aids in the Great Lakes region. These aids come in all shapes and sizes, and include lighted structures, beacons, day markers, range lights, fog signals, landmarks and buoys. The Ninth Coast Guard District utilizes six Coast Guard cutters, five aids-to-navigation teams and five small-boat stations to manage the extensive Aid to Navigation system in U.S. waters. The Saint Lawrence Seaway Development Corporation (SLSDC) maintains 99 lighted buoys and 112 fixed aids in the U.S. section of the St. Lawrence River.

The CCG's Central and Arctic Region maintains aids to navigation in the Great Lakes-Seaway from bases at Prescott and Parry Sound, with subsidiary bases located at Amherstburg and Thunder Bay. For the complete Central and Arctic Region, approximately 7,100 short-range fixed and floating aids to navigation, such as buoys, ranges, radar beacons and light stations, are maintained for use by commercial, charter and recreational boaters.

International cooperation agreements are in place between the two countries (*Operation Spring Restore* and *Operation Fall Retrieve*) to place aids in the spring and remove them before the winter, and to ensure all aids to navigation are on station and functioning properly.

7 Squat is a phenomenon whereby hydrodynamic pressure acting on the bottom of a vessel in shallow waters draws all or part of the vessel closer to the bottom in proportion to the square of the vessel's speed.

2.5 Pilotage

Skilled navigators with local knowledge are a critical component of safe navigation on the confined waters of the Great Lakes. Marine pilots, trained and experienced in navigating local waters, fulfill this role. A pilot boards foreign ships entering the local waters of the Great Lakes-Seaway and advises the ship's captain on navigational aspects as the ship proceeds to its destination port and back.

All waters of the Great Lakes- Seaway are designated as compulsory pilotage zones; however, U.S. and Canadian domestic ships meet this requirement through demanding USCG licensing programs for U.S. deck officers. Canadian deck officers follow a similar system through the Great Lakes Pilotage Authority's Pilotage Certification Program. Extensive training, examination and assessment of skills, mandatory trips, marine officer credentials and rigorous physical examinations all support the knowledge, skills and capabilities of domestic mariners to conduct their pilotage responsibilities.

The waters of the Great Lakes-Seaway are divided into designated areas of responsibility — with Canadian waters handled by Canadian pilots and U.S. waters by U.S. pilots.

Pilotage requirements on Canadian waters are under the oversight of Transport Canada. In the Great Lakes-Seaway, the requirements are administered by the Great Lakes Pilotage Authority for the waters west of Montreal and by the Laurentian Pilotage Authority for the region east of Montreal.

Pilotage requirements on U.S. waters are set under the authority and oversight of the USCG's Office of Great Lakes Pilotage in Washington, D.C. The U.S. pilotage organizations include the St. Lawrence Seaway Pilots Association, the Lake Pilots Association and the Western Great Lakes Pilots Association.

In designated waters, foreign-flag vessels and U.S. vessels operating on a registry endorsement (i.e. endorsed to engage in foreign trade) are required to take a U.S.- or Canadian-registered pilot when underway on the Great Lakes. Reciprocity between Canada and the U.S. on the Great Lakes has its basis in the *Boundary Waters Treaty* of 1909. Reciprocity applies to the lakes, rivers and connecting waters of the Great Lakes pursuant to the treaty — Canada accepts U.S. lake and river pilotage certifications for U.S. vessels traversing the Canadian waters of the Great Lakes and the U.S. accepts Canadian pilotage certifications for Canadian vessels traversing the U.S. waters of the Great Lakes.

2.5.1 Great Lakes Pilotage Training Programs

Both Canada and the U.S. have extensive training programs in place to ensure skills and capabilities exist for pilotage in the rivers, ports and lakes of the Great Lakes-Seaway. In the U.S., successful training, experience and examination lead to the USCG issuing First Class Pilotage Licenses to qualified Masters and Mates (for applicable-sized vessels and designated waters).

In Canada, after successful training, experience, assessment and/or examination, Pilotage Certificates are issued to qualified Masters and Mates (again, for applicable vessels and designated waters). Professional pilots undergo similar training, assessments and examination, and are issued Pilotage Licenses to verify their competence for pilotage duties.

2.5.2 Pilotage Training Standards and Availability

With the availability of developed navigational databases on pilotage waters in the Great Lakes-Seaway, marine training schools in Canada and the U.S. offer extensive simulator training courses in ship handling, emergency ship handling and pilotage for areas of the St. Marys River, Detroit/St. Clair Rivers, Welland Canal and St. Lawrence River. Detailed geographic visual details combined with accurate river currents and realistic ship models provide training opportunities for Masters, Mates and company personnel to practise and enhance their pilotage skills in the compulsory pilotage waters of the Great Lakes-Seaway. Georgian College in Canada, and STAR Center and Great Lakes Academy in the U.S. are examples of where these training resources are available.

2.6 Safety Measures in Ice Conditions

Due to icing, the Seaway does not operate in full winter and the Soo locks shut for one month. Consequently, there are very few vessel movements on most of the Great Lakes-Seaway under full ice conditions. However, for the transition periods and those operations that continue through the year (e.g. moving short-distance cargoes such as safety-critical road salt), icebreaking is an important aid. Icebreaking support services for the commercial marine industry are co-ordinated between the U.S. and Canadian Coast Guards, and provide a seamless and safe waterway system during periods of ice conditions.

Close co-operation and communication are always in place between the commercial ships and Canadian and U.S. Coast Guard ice operations.

The USCG has a fleet of eight ships (one large and seven small) home-ported in the Great Lakes with the responsibility, in part, to conduct icebreaking. The CCG has two large ships home-ported in the Great Lakes with similar icebreaking responsibilities. These vessels provide icebreaking assistance to ensure that ships, their crews and cargoes safely reach their destinations.

Close co-operation and communication are always in place between the commercial ships and Canadian and U.S. Coast Guard ice operations. Daily operational and strategy-planning meetings are conducted throughout the winter season to promote operational efficiency and efficient flow in the marine transportation system. When necessary, the USCG Captain of the Port and the Canadian Marine Traffic and Control Centres place operational restrictions on vessels based on weather and ice conditions. Ice-routing recommendations are provided by the responsible Coast Guard to the commercial industry, based on known conditions and optimum routes. Daylight-only navigation restrictions may be implemented during "difficult" ice conditions, and vessels' power capabilities are assessed to ensure safe passages and to determine the need for icebreaker assistance where required.

The CCG maintains an "ice operations office" at its Sarnia Vessel Traffic Service Centre. Current and historical data, planning of icebreaking resources, monitoring of commercial traffic and future transits, ice reconnaissance, ice and weather forecasting, and overall management of winter navigation are all coordinated from this office. The effort is a joint approach, with the USCG participating on the ice operations team. The result is a coordinated management of ice-support services for the commercial marine industry during periods of ice conditions on the Great Lakes.

Similar "ice management" operations exist with the USCG and Soo Control for the St. Marys River. Additionally, when the Seaway has operations during winter navigation periods, a joint effort between the Canadian and U.S. Seaway Corporations and the CCG results in a seamless and safe waterway system during periods of ice conditions. If and when icebreaking is needed for the lower Seaway, the ability to "cascade" icebreakers in from the CCG's Laurentian Region facilitates the availability of icebreaking resources to assist the Seaway authorities and the commercial marine industry.

2.7 Tug and Towing Services

Commercial tug and towing-services companies are located all along the Canadian and U.S. sides of the Great Lakes and are available to assist ships that are navigating restricted waterways. The role of tugs is to assist commercial vessels as needed via escorts or tows when emergencies arise, and to generally assist in the maneuverability of large cargo vessels during berthing and unberthing operations in ports and harbors.

Commercial tug and towing-services are available to assist ships that are navigating restricted waterways.

U.S. Coast Guard regulations require tank ships to contract with towing vessels should an emergency (such as grounding, fire or collision) occur. More generally, every commercial vessel in the Great Lakes under Canadian or U.S. regulations is required to identify appropriate salvage resources that are available for responding to major incidents. These resources must be incorporated into the vessel's Shipboard Oil Pollution Emergency Plan/Non-tank Vessel Emergency Response Plan.

Tugs also support the commercial marine industry with icebreaking assistance in the more remote areas of the Great Lakes that are less frequently visited by Canadian and U.S. government icebreaker resources.

2.8 Tanker Safety Requirements

Liquid bulk cargo is transported on the Great Lakes-Seaway by Canadian, American and international vessel operators. Liquid bulk commodities include petroleum products, crude oil and chemicals other than fertilizer.

Liquid bulk cargo is transported in specially designed tank ships (self-propelled tankers) and tank barges. In the Great Lakes-Seaway, tankers typically transport petroleum products and liquid chemicals. Tank barges (non-powered vessels pulled or pushed by a tug) are typically used to transport asphalt and heavy oil.

The U.S. and Canadian governments have adopted environmental safety standards for new and existing petroleum-product tankers entering Canadian or U.S. waters. These standards require that petroleum tank ships be built to specific double-hulled standards, resulting in a safety separation between the inner cargo compartments and the ship's outer hull of between 1 and 2 metres (3.3 to 6.6 ft.), depending on the DWT capacity of the tanker.[8] The U.S. *Oil Pollution Act of 1990* requires tank vessels to meet or exceed double hull specifications by the year 2015.

The International Maritime Organization (IMO) adopted similar international standards for oil tankers in 1993 and Canada adopted those standards under the *Canada Shipping Act* in the same year. The timeframe associated with the original regulations in Canada were updated in 2003 and required pre-1993 oil tank vessels over 5,000 gross registered tonnage to be double hulled by 2010 if they were single hull and by 2015 if they were either double sided or double bottomed.[9]

8 The formula for the width of the space is W (in metres) = 0.5 + DWT/20,000 with a minimum space of 1.0 metres and a maximum of 2.0 metres.
9 Transport Canada, Standards for the Double Hull Construction of Oil Tankers - TP 11710 E, 2009, – paragraph 22 and 23 of Part II.

3 Mariner Expertise, Certification and Training

3.1 International Training Standards and the STCW

Internationally, marine standards (known as "conventions") are set by the *International Maritime Organization* (IMO), a branch of the United Nations. The IMO's mandate is to set international maritime standards for safety and pollution prevention. Specific to training standards, the *Standards for the Training and Certification of Watchkeepers* (STCW) is an IMO Convention that sets the criteria for training for seafarers, including in areas of navigational safety. The STCW set baseline training standards for the training and education of seafarers throughout the world, by placing an emphasis on quality control and competence-based training. The STCW Convention and Code cover training standards in the following areas:

- General areas for compliance, port state controls, quality standards and fitness standards;
- Master and Deck Department;
- Engine Department;
- Radio Communication;
- Special Training for Unique Ships;
- Emergency, Occupational Safety, Medical Care and Survival;
- Alternative Certification; and
- Watchkeeping, including fatigue management.

Prior to IMO developing a "model" training course for the Electronic Chart Display and Information System (ECDIS) as an international standard, Great Lakes mariners were being formally trained on the Electronic Chart System (ECS), and their initial ECDIS training course became the basis for the IMO-developed syllabus.

While the current edition of STCW 95 is in place, recent amendments to the STCW were adopted in 2010 to cover modern and current navigational technology in use such as electronic charts, as well as human resource management issues, including hours of work and rest, awareness and knowledge, with environmental training and updated tanker training standards. Canadian and U.S. mariners and shipping companies endorsed and implemented this modern technology long before it became standard equipment in the international marine industry.

The international STCW and the *Maritime Labour Convention* set the framework for training and safety. The U.S. Coast Guard (USCG) and Transport Canada adapt these standards to the specific requirements of training and safety on the Great Lakes. Canada and the U.S. have a "memorandum of understanding" in place to accept each other's marine training standards, and the maritime documents and licensing/certification of their respective seafarers on the Great Lakes-Seaway.

Although vessels that operate exclusively on the Great Lakes do not require STCW certification, both Canadian and U.S. regulations ensure there is a professional equivalency between domestic and international seafarers.

3.2 Mariner Certification and Training

Companies operating on the Great Lakes-Seaway supplement the international training standards and Transport Canada/USCG regulatory training standards for domestic ships, with industry and company-specific training programs. Individual companies operating on the Great Lakes may have different training standards and criteria to meet their own needs and those of their personnel; however, all companies now have formal training programs in place under quality and safety management systems to ensure competence among their seafarers and to ensure Masters and Navigation Officers meet high levels of pilotage and navigational skills.

The Great Lakes and St. Lawrence River are considered "confined" waters, whereby ships navigate in rivers with currents and constricted channels, maneuver in the many ports and harbors (often without the assistance of tugs), and frequently meet ships in close proximity in the canals and river systems. Crew training involves a blend of international training standards (developed to address common requirements of crews on any ocean-going vessel) and company training standards (developed to address the specific navigational requirements of the domestic waters on which these crews operate).

In Canada and the U.S., becoming certified as a Master (Captain) takes a minimum of between six and eight years and given the need for gaining necessary experience, often longer.

Commercial vessels operating on the Great Lakes-Seaway are under the control of professional mariners that have not only received specialized educations, but have also been licensed by government authorities. A ship's captain, for example, will have graduated from an accredited maritime academy or university program, and will have accumulated years of experience and passed a series of examinations before obtaining a Master's ticket. In the United States, licensing of merchant mariners is the responsibility of the USCG. In Canada, licensing is the responsibility of Transport Canada.

Industry associations such as the Canadian Shipowners Association undertook and developed navigational area, specific training programs in ship handling, emergency ship handling, and pilotage (for the St. Lawrence, Detroit/St. Clair, and St. Marys Rivers) utilizing modern simulators for training. The Masters and Mates of Association members undergo extensive five-day training courses for each navigational area, to enhance their skills and provide the company with formal training assessments. These training programs have been in place since 1980, and recent upgrades of ship models and expanded areas are now available.

In Canada, becoming Master of a "laker" or "ocean-going ship" takes a minimum of eight years in various cadet/junior officer positions to continue the process of gaining experience and skills, and passing examinations — and this time period is often longer, depending on the individuals' opportunities to gain experience. Formal education often begins as a Navigation Cadet, at one of the four Canadian marine-training schools across Canada that are recognized by Transport Canada. The schools provide

formal marine training and initial Certificates of Competency through a three-to four-year degree program. Employment commences as a junior officer. Before obtaining a Master's Certificate, a mariner must acquire additional sea time, complete service in the junior and more senior ranks of Third, Second and First Navigation Officer on specified ship sizes and geographic waters, and take additional examinations. The final step is successful completion of Transport Canada's examinations, leading to issuance of a Certificate of Competency as a Master.[10]

Similarly, the U.S. system requires progressive experience as a Third mate, Second Mate and Chief Mate, before an individual becomes a candidate for a ship's Master. In terms of the associated qualifying experience:

- Third-mate qualification requires 1,080 days of deck service, after which one may attend a maritime academy, then take the licensing exam;
- Qualification as a Second Mate requires an additional 360 days sailing as a Third Mate;
- Chief Mate qualification requires an additional 360 days sailing as a Second Mate; and
- Qualification as a Master requires an additional 360 days sailing as a Chief Mate.

At each stage, a candidate needs to pass written and oral tests to be licensed, and complete other courses such as firefighting and the radar observer course, obtain letters of recommendation and hold a Transportation Worker Identification Credential (TWIC®).

It should be noted that 360 sailing days may translate to two years or more, depending on the amount of sailing time per year. Thus, to become a Master, a person would need at least six years of sailing experience before qualifying and most likely, it would take 8 to 10 years for the individual to acquire that experience.

Obtaining a Master's Certificate does not necessarily mean that one will get command of a ship. This is determined by shipping companies/managers, who monitor and evaluate the individual's experience, training and assessment of skills before appointing them to a Master position. Company training programs for Masters include service on different ship types; a period of sailing with "Training Masters;" completion of additional training on simulators for ship handling and pilotage, and bridge resource management; and other management courses. (Training Masters are the best of their trade who cultivate the technical expertise and leadership necessary for command for aspiring Masters.) A "Master-in-Training" often undergoes 6 to 12 months of additional onboard training under Training Masters, with formal assessments documented.

3.3 Technology in Training

Navigational tools incorporating electronic chart systems, satellite GPS and the Automatic Identification System (AIS) are examples of modern technology supporting safe waterways and navigation worldwide, and specifically on the Great Lakes Seaway. Canadian and U.S. mariners and shipping companies endorsed and implemented this technology long before it became standard equipment in the international marine industry.

Prior to the IMO developing a "model" training course for ECDIS as an international standard, Great Lakes mariners were being formally trained on Electronic Chart Systems (ECS), and in fact, their initial ECDIS training course became the basis for the IMO-developed syllabus.

10 Transport Canada's training syllabus for a Master to command a ship on the Great Lakes requires schooling education and examination in multiple subjects covering communications, navigation systems, chart work and pilotage, navigation safety, meteorology, ship management, ship construction and stability, cargo, engineering knowledge, general ship knowledge, simulated electronic navigation, marine emergency duties (firefighting and lifesaving), security and first aid, plus an oral examination with a Transport Canada Examiner. All certificates undergo a five-year renewal and re-validation process, with marine medicals also periodically required.

Simulator training for ship handling — that uses models/databases specific to Great Lakes ships and navigable waterways — has been the industry training standard for ship owners on the Great Lakes for more than 30 years. Ship handling and bridge resource management training is undertaken in the U.S. and in Canada at recognized marine centers including the Massachusetts Maritime Academy; the Great Lakes Maritime Academy; the American Maritime Officers STAR Center; the Marine Institute of Technology; the Graduate Studies facility in Linthicum, Maryland; the Maritime Simulation Institute (Newport, Rhode Island); the Marine Institute of Memorial University (St. John's, Newfoundland); Georgian College (Owen Sound, Ontario) and Institut maritime du Québec (Rimouski, Québec). International training facilities in Southampton, England and Grenoble, France, which utilize ship models, are also used in Master and Navigation Officer training programs.

Simulator training for ship handling which uses models/databases specific to Great Lakes ships and navigable waterways has been the industry training standard for Canadian ship owners on the Great Lakes for more than 30 years.

At these centers, mariners develop new skills and a better understanding of a ship's behavior when sailing in restricted water conditions at maneuvering speed. Training is conducted by exposing the mariner to challenging and emergent situations to test their capacity to work effectively under stressful conditions. The use of simulators permits extreme training situations that would be too hazardous aboard an actual ship and tests the mariners' ability to best use their bridge team management and crisis coordination skills.

4 Workplace Safety and Risk Management

4.1 Introduction

Safe operations are attained through risk management practices. By definition, risk is the product of the frequency of accident occurrences and the severity of the consequences when an accident occurs. One can only achieve safety by addressing both these components. One can strive to achieve a very low frequency of accidents; however, there will always be some chance of an occurrence and when it does occur, one needs to be sure that the consequences are as low as possible.

Risk management goes hand-in-hand with proactive company management. Quality and safety management systems have components of risk management within their structures, and most shipping companies, including those on the Great Lakes, utilize the principles of effective risk management in their operational structures. While the elimination of all risks in any business is impossible, the effective management of risks is critical to mitigating impacts and improving safety.

The fundamentals of risk management include the following:

- Risk event identification (possibility of an unsafe occurrence);
- Consequences assessment (are they acceptable or not acceptable?);
- Analysis of measures to mitigate or eliminate the risk;
- Implementation of identified measures; and
- Ongoing improvements in risk management process.

4.2 Company Safety Programs/ Safety Culture

Great Lakes shipping companies have established a safety culture within their organizations both amongst management and their employees. In addition to voluntarily incorporating safety management systems into organizational structures (e.g. through the adoption of the *International Safety Management (ISM) Code* and the *ISO 9001-2008 Standard*), companies have further advanced safety through the adoption of behavioral safety methodologies, with the engagement of all levels of company employees. Safety meetings on board are often supplemented with employer/employee safety meetings to reinforce safety and ensure commitment to safety from all levels.

Great Lakes shipping companies have established a safety culture in addition to voluntarily incorporating safety management systems into organizational structures.

4.3 Regulatory Compliance with Occupational Health and Safety for Crews

The Great Lakes-Seaway shipping industry follows a number of safety practices and training standards, and uses the latest advances in navigational technology to reduce its risk of workplace accidents. Just as employees "on shore" adhere to workplace safety principles and practices, ships and their onboard crews of 15 to 25 members per vessel comply with and promote all aspects of "safety on the jobsite." Safety policies and procedures are supported and enhanced by the onboard presence of assigned safety officers and elected safety representatives; regularly scheduled safety meetings and exercises; and company-developed programs aimed at building a safety culture supporting accident-free worksites.

In the U.S., workplace safety on board vessels falls under the oversight of the U.S. Coast Guard (USCG). The USCG is the lead federal agency with the statutory authority to prescribe and enforce standards and regulations affecting the occupational safety and health of seamen aboard commercial and passenger vessels that are subject to USCG inspection requirements. Under the vessel inspection laws of the United States, the USCG has issued comprehensive standards and regulations concerning the working conditions of seamen aboard all inspected vessels. Further, the USCG has the sole discretion to determine if a vessel complies with these standards and regulations.

In Canada, Transport Canada administers Part II of the *Canada Labour Code* and the *Marine Occupational Health and Safety Regulations*, on behalf of the Minister of Labour. The Regulations cover all aspects of the work environment on board ship, including: sleeping and eating facilities; personal protective equipment to be worn and used by workers; standards for lighting, noise and vibration; procedures for undertaking welding repairs and entering confined spaces; safety procedures for use of tools and equipment; and information on the safe handling of chemicals and cleaning materials. Examples of safety coverage include: structures (e.g. ladders, stagings and ship-access areas); crew accommodations; fire protection and emergency training; medical care and first aid; boilers and pressure vessels; hazardous substances, including identification and management of asbestos, mercury, lead and other substances; and hazardous occurrence recording and reporting.

4.4 Landside (Ports and Seaway)

Ports and marine facilities also have safety programs and a stated commitment to safety in the workplace. Oversight of responsibilities related to safety on landside facilities falls under various regulatory authorities. In the U.S., port operations must comply with all *Occupational Safety and Health Act* requirements. In Canada, shoreside workers must meet Transport Canada's *Marine Occupational Health and Safety Regulations* when on board ship; Labour Canada standards are in place for other port and terminal shoreside operations. Inspections and the response plans of ports and marine facilities are often delegated to inspectors with provincial ministries of labor.

4.5 International Safety Management (ISM) Code

Today's standards of ship operation and ship management clearly define the responsibilities for an effective safety management system with policies, procedures and work instructions. Ocean-going vessels on international voyages must follow the IMO conventions for *Safety of Life at Sea (SOLAS)* and must meet the ISM Code,[11] which is a formalized, audited and certified safety management system for the prevention of accidents and the protection of the environment. The specific objectives of the ISM Code are to:

1. *Provide for safe practices in ship operation and a safe working environment;*
2. *Assess all identified risks to ships, personnel and the environment and establish appropriate safeguards; and*
3. *Continuously improve safety management skills of personnel ashore and on board.*

11 Under IMO's Resolution A.741(18), as amended by MSC.104(73), MSC.179(79), MSC.195(80) and MSC.273(85).

Ships and companies adhering to the ISM Code must have a functional safety management system that includes: a commitment from senior management; formal and top-level policies; formal and documented procedures outlining operations on board ship, for both normal operations and emergency operations; processes for internal and external audits for verification; a Designated Person Ashore with direct links between the ships and shore management and senior management; a system for identifying weaknesses/risks and implementing corrective actions; and a process for regular reviews of the overall safety management system.

Ships and companies are "certified" as meeting the requirements of the ISM Code by independent and flag-state-recognized authorities, after undergoing detailed and regularly scheduled audit processes. Classification societies usually perform these auditing services, and both the classification societies and the ship owners are subject to further audits and verification from representative flag-state authorities. While the ISM Code is not mandatory for Canadian and U.S. domestic vessels, most Great Lakes operators have voluntarily adopted recognized safety management systems.

Ocean-going vessels on international voyages must follow the IMO conventions for Safety of Life at Sea (SOLAS) and must meet the ISM Code

4.6 International Organization for Standardization (ISO)

The *ISO 9001-2008 Standard* deals with the fundamentals of quality management systems, and has been adopted by many Great Lakes shipping companies to ensure their quality management systems meet the needs of customers and other stakeholders. This Standard includes the following management principles: customer focus; leadership; involvement of people; process approach; systems approach to management; continual improvement; factual approach to decision making; and mutually beneficial supplier relationships.

In part, the ISO Standard requires that a service company undertake the following steps and/or exhibit the following characteristics (as abridged from the ISO 9001):

- Establish a "quality policy that must be understood and followed by all levels of the company with each employee working towards measurable objectives;"
- Decisions about the quality management system must be based on documented data and information;
- It is regularly audited and evaluated for conformance and effectiveness;
- Formal documentation of the services provided allow the performance and any problems to be identified and corrected;
- Customer requirements remain the focus of the business;
- Systems are in place for all aspects of effective customer and stakeholder communication;
- Any new service must be planned, tested and documented to ensure it meets all requirements;
- Regular reviews of service performance are undertaken through internal audits and meetings to evaluate the service and determine continual improvements;
- Any past and potential issues are dealt with, including related documentation and monitoring of improvement effectiveness; and,
- There are documented procedures for addressing actual and potential non-conformances.

Similar to the ISM Code, the ISO Standard is subject to independent confirmation that standards are being met, through internal and external audits by independent certified third parties.

4.7 Insurance

Vessel insurance includes two components: hull and machinery coverage (which protects the owner from damage costs incurred to the vessel) and liability coverage (Protection & Indemnity that covers third-party damages). All insurance companies that underwrite damage and liability coverage have risk management programs and assistance for their marine clients. Insurance professionals in risk management undertake a variety of risk management services for the purposes of reducing accidents. Examples include the following: vessel condition surveys; risk information and reference resources; risk assessment assistance by specialized personnel; training courses and programs in risk assessment; and in-house technical expertise in risk management, navigation, engineering, naval architecture, cargo and marine operations.

Ship owners/operators carry Protection & Indemnity insurance coverage to ensure adequate resources are available for any environmental emergency or pollution response. Both the U.S. Coast Guard (USCG) and Transport Canada require ships to have Certificates of Financial Responsibility, which confirm that valid and adequate insurance protection is in place and the financial capacity to effectively respond to an oil spill or accident. All vessels over 1,000 gross registered tonnage (GRT) are required to have liability insurance for oil spills, and oil tankers require additional insurance.

In the U.S., the *Oil Pollution Act of 1990*, with limits of liability amendments, requires pollution-coverage insurance of $1,200 per GRT for a single-hull ship up to 3,000 GRT; other ship types and sizes require other amounts. Canada has similar financial requirements based on different ship sizes under the *Marine Liability Act*, and all ships are required to carry valid proof-of-insurance coverage through their Protection & Indemnity clubs. These requirements are mandated by regulation and vessels are not able to sail without this coverage and certificate. This applies to both domestic and foreign ships in Canadian and U.S. waters.

4.8 Ship-source Oil Pollution Funds

Canada and the United States have government-authorized funds and administrations to manage oil pollution claims not recoverable from the polluter.

Ship-source Oil Pollution Funds are in place in both Canada[12] and the U.S.[13] to facilitate response procedures and to initially accept liability for containment and cleanup of a ship-source oil spill. The funds were developed through tax levies on petroleum importers, exporters and producers. No levies have been needed to bolster the Canadian fund for some time; however governments have the authority to suspend and reintroduce levies as deemed necessary.

A major benefit of the Ship-source Oil Pollution Funds and the associated *Liability Acts* is that government agencies and response organizations can immediately proceed to allocate resources, without concern about who is liable and whether they will be compensated for response efforts. The Funds accept liability for payment and, in turn, pursue restitution from the party ultimately responsible for the spill. The responsible party (e.g. vessel operator/owner and/or marine facility operator/owner) is legally liable and the funds pursue compensation from those companies and their insurers. Additional compensation can be drawn from the International Oil Pollution Compensation Fund for internationally flagged tanker spills in domestic waters.

12 The Ship-source Oil Pollution Fund (SOPF) was established in Canada under the *Marine Liability Act* in 1992.
13 The Oil Spill Liability Trust Fund (OSLTF) was enacted in 1990 in conjunction with the *Oil Pollution Act of 1990*.

4.8.1 Canada's Ship-source Oil Pollution Fund

Information on Canada's Ship-source Oil Pollution Fund (SOPF) is available from the annual reports of the Office of the Administrator of the Ship-source Oil Pollution Fund. Some key facts are noted here.

Canada's SOPF was established under the *Marine Liability Act* to ensure payment of claims for marine oil pollution that originate from ships in Canadian waters — including from spills in the exclusive economic zone, in the event of non-payment by the ship owner whose vessel is responsible for the pollution.[14] This further includes claims for damage and cleanup costs, where the identity of the ship that caused the discharge of oil cannot be established (i.e. a "mystery spill").

The SOPF is funded from a fee levied on marine-transported oil and oil products. The Administrator of the SOPF is obligated to attempt recovery of claim costs from the "polluter." Other revenue is generated from interest sources. The SOPF is also the Canadian source of funding for Canada's contributions to the International Ship Pollution Fund.

The SOPF is unique in that it not only covers sea-going tankers, but it is designed to pay claims from oil spills from all classes of ship, such as general cargo vessels, cruise ships, ferries and other non-tankers. The SOPF can also provide compensation if international funds are insufficient to meet all established claims for compensation from oil tankers in Canada.

4.8.2 U.S. Oil Spill Liability Trust Fund (OSLTF)

The U.S. Oil Spill Liability Trust Fund (OSLTF) was established in 1990 in conjunction with the *Oil Pollution Act of 1990*. The purpose of the fund is to provide compensation for those who have suffered losses or damages due to an oil spill. Funding of the OSLTF is through a "barrel tax" — collected from the oil industry on petroleum produced in or imported to the United States; transfers of funding from other existing pollution funds; interest from the overall funds; and costs recovered from the "polluters" and from assessed penalties. The fund is administered by the USCG's National Pollution Fund Center.[15]

The funds from the OSLTF are for the designated purposes of: removal costs incurred by the Coast Guard and the Environmental Protection Agency; state access for removal activities; payments to federal, state, and Indian tribe trustees to conduct natural-resource damage assessments and restorations; payment of claims for uncompensated removal costs and damages; research and development; and other specific appropriations.

The OSLTF has two available funding mechanisms. The Emergency Fund of $50 million annually is available for use by federal emergency managers known as On-Scene Coordinators to ensure pollution response is done as quickly as possible, and for federal trustees to use to initiate natural-resource damage assessments. The remaining Principle Fund is used to pay claims and to fund appropriations to federal agencies to administer the provisions of the *Oil Pollution Act* and support research and development.

14 The accumulated surplus in the SOPF as at March 31, 2012, was $395.8 million. (*SOPF Annual Report 2011-2012*)

15 The OSLTF balance is forecast to be $2.45 billion by the end of FY 2013.

5 Emergency Preparedness and Response

Recognizing the importance of the Great Lakes and the potential for an environmental accident to occur, Canada and the United States have enacted laws, passed regulations and reached agreements to address the prevention of and response to a marine incident.

5.1 Legislation

At the international level, both Canada and the U.S. have ratified *MARPOL 73/78* — the *International Convention for the Prevention of Pollution from Ships, 1973* (as modified by the Protocol of 1978). The Convention includes regulations aimed at preventing and minimizing pollution from ships — both accidental pollution and pollution stemming from routine operations — and currently includes six technical Annexes (oil; noxious liquid substances carried in bulk; harmful substances carried in packaged form; sewage; garbage; and air pollution).

The flag state is responsible for certifying the ship's compliance with MARPOL's pollution prevention standards.

Specific to oil spills, both Canada (under the *Canada Shipping Act, 2001* and prior 1993 Act) and the U.S. (under the *Oil Pollution Act of 1990*) have legislation in place that requires oil-carrying vessels and oil-handling landside facilities to have emergency response plans including regular — at a minimum yearly — training exercises. In addition, sub-regions of the Great Lakes-Seaway must have area response plans and the equipment necessary to contain/remove petroleum spills.

5.1.1 U.S. Legislation

The primary legislation addressing oil spills in the U.S. is the *Oil Pollution Act of 1990*. The Act expanded the spill-related provisions of the *Clean Water Act* by improving the nation's ability to prevent and respond to oil spills, and created the national Oil Spill Liability Trust Fund (OSLTF). The Act also created new requirements for contingency planning, both by government and industry. The pre-existing National Oil and Hazardous Substances Pollution Contingency Plan was expanded to include a three-tiered approach:

- Tier One: requires the federal government to direct all public and private response efforts for certain types of spill events;
- Tier Two: requires the formation of Area Committees composed of federal, state and local government officials to develop geographic-specific Area Contingency Plans; and
- Tier Three: requires owners or operators of vessels and certain facilities that pose a serious threat to the environment to prepare Vessel Response Plans and Facility Response Plans, as appropriate. Further, the owners and operators of tank vessels are required to establish and maintain Vessel Response Plans, appoint Qualified Individuals and contract recognized Oil Spill Response Organizations to ensure rapid and effective response.

Finally, the *Oil Pollution Act of 1990* increased penalties for regulatory non-compliance, broadened the response and enforcement authorities of the federal government, and preserved state-government authority to establish laws governing oil spill prevention and response.

5.1.2 Canadian Legislation

The *Canada Shipping Act, 2001* applies to Canadian vessels operating in all waters and to all vessels operating in Canadian waters.

Private sector oil-spill response organizations were established in 1995 to enable industry to respond to oil spills of up to 10,000 tonnes in Canadian waters. It requires that all oil tankers of 150 gross registered tonnage (GRT), all other vessels of 400 GRT trading in Canadian waters, and all oil-handling facilities located within Canadian jurisdiction have arrangements with response organizations. These arrangements are administered by Transport Canada, as part of its responsibility for the overall Canadian Oil Spill Response Regime.

Transport Canada's *Vessel Pollution and Dangerous Chemicals Regulations*, updated in 2012, are all-inclusive — covering standards and regulations for oil, noxious liquids and dangerous chemicals, marine pollutants, sewage, garbage, air and pollutant substances.

5.2 Preparedness on the Great Lakes-St. Lawrence Seaway System

5.2.1 Joint U.S.-Canada Agreements

Canada and the U.S. have a long history of working together on environmental preparedness, prevention, planning, and response training and exercises. The *Boundary Waters Treaty* of 1909 was one of the first treaties that provided mechanisms for resolving any dispute over any waters bordering the two countries.

Pursuant to the *Great Lakes Water Quality Agreement* of 1972, Canada and the U.S. agreed to work together to ensure quick and effective collaboration in the event of an environmental incident in shared waters. The Agreement was amended in 2012 to facilitate joint action on threats to Great Lakes water quality and includes measures to prevent ecological harm. The Agreement also supports continued work on existing threats to people's health and the environment in the Great Lakes basin, such as harmful algae, toxic chemicals and discharges from vessels.

The *Great Lakes Water Quality Agreement* also recognized the need for the establishment of an international marine pollution contingency plan for contiguous waters. This led to the Canada-United States Joint Marine Pollution Contingency Plan for the Great Lakes, which was promulgated in 1974. The purpose of the Plan is to provide a coordinated system for planning, preparedness and response to harmful-substance incidents in the contiguous waters. The Plan and its Geographic Annexes augment the national response systems of Canada and the United States by providing a "bridge" between the two systems — ensuring that coordinated planning is accomplished at the local level. Responses to harmful-substance incidents are carried out under the provisions and procedures of each country's national response system.

5.2.2 Preparedness Training

Training is the key to the federal strategy for preparing for oil spills or hazardous substance releases. Although most training is performed by state and local personnel, the U.S. National Response Team develops training courses and programs, coordinates federal training efforts, and provides information to regional, state and local officials about training needs and courses.

On the Great Lakes, the Canadian and U.S. Coast Guards, and state/provincial agencies sponsor pollution-response training for key response personnel. Training is included in most routine operational exercises and during the bi-annual CANUSLAK[16] exercise. The Great Lakes exercise program is an important element in the cooperative approach that will allow responders to test and continuously improve a broad range of pollution-response activities, which would be jointly undertaken in the event of a major pollution incident. Due to the harsh winter climate and unique challenges of oil spills during the winter months, specialized training for oil-recovery procedures in snow and ice conditions is also provided to federal, state/provincial and local response personnel.

16 CANUSLAK refers to the Canadian/ U.S. Lakes Annex to the Joint Marine Pollution Contingency Plan. This Plan was developed over 30 years ago in accordance with the Great Lakes Water Quality Agreement. A Joint Response Team, comprised of response agencies from Canada and the United States, is co-chaired by the Canadian Coast Guard and the U.S. Coast Guard.

Annual emergency response exercises are required by each port and marine facility. The exercises range from table-top simulations, to mixed table-top and field exercises, to full-blown field simulated events. An example of a full-blown field exercise is the joint U.S.-Canada simulation of a fire on a truck-ferry transporting hazmat/dangerous-goods between Detroit and Windsor.

5.2.3 Incident Command System

For any large-scale emergency, it is imperative to have a response organization and to test it prior to any event. Both Canada and the U.S. have developed response organizations that, while not identical, are compatible.

The U.S. has implemented the National Incident Management System, which is used nationwide to respond to natural disasters or terrorist attacks at the local, state and federal levels of government. The National Incident Management System provides a framework within which government and private entities at all levels can work together to manage domestic incidents, regardless of their cause, size, location or complexity. It provides a set of standard organizational structures, as well as requirements for processes, procedures and systems designed to improve operability among jurisdictions and disciplines in various areas.

Canada has implemented the Response Management System, based upon a "management by objectives" philosophy, in which objectives are established based upon the needs of the specific circumstances. It provides the necessary coordination to facilitate effective and efficient monitoring or response operations to an incident in virtually any situation.

The Response Management System and the National Incident Management System are very similar but have some differences in incident-command structure. When appropriate, the two countries exchange liaison officers, who integrate into their counterpart organizations and take on valuable coordination and communication responsibilities.

5.2.4 Response Command Structure

In the event of a marine oil spill/emergency in Canada or the U.S., the following command structure is in place:

- The Coast Guard (Canadian or U.S., depending on jurisdiction) is the first in line-of-command for oversight and response at a spill site. The federal oversight role is first to ensure that the Responsible Party's response is effective. Their second role is to assume full execution of the cleanup if there is no identified Responsible Party or if the Responsible Party cannot or will not effectively respond.
- Port and infrastructure management agencies (e.g. spills in harbors or in Seaway locks/channels) notify all relevant responders and offer assistance in whatever way they can provide, including containment if they have local resources.
- Oil-response organizations are usually the first responders and address containment and recovery objectives for the spill.
- The responsible entity (usually a vessel owner) is responsible for the costs incurred and generally has indemnity insurance in excess of the minimum required to cover the costs of a major spill. Moreover, the responsible entity also has the primary responsibility to execute and coordinate the response under the oversight of the Coast Guard.
- If required, publicly administered Oil Pollution Funds are available in both countries for payment to those incurring damage or containment costs. Recovery of the funds is sought from the responsible entity and/or insurance company after the cleanup operations are completed.

Cooperative training and joint responses to spills are facilitated by international and joint agreements, as discussed below.

5.3 Oil Spill Response

While the response structures are slightly different in Canada and the U.S., their goals of implementing a timely and capable response to any spill remain the same.

5.3.1 U.S. National Response System

The first U.S. national system for spill response and reporting, the National Multi-Agency Oil and Hazardous Material Contingency Plan, was developed after the major oil spill off the coast of England in 1968 (Torrey Canyon). The National Response System continued to develop over time but it wasn't until the 1990s, following passage of the *Oil Pollution Act of 1990* and development of the National Contingency Plan, that the National Response Team was established. This organization, comprised of 15 federal government agencies, is co-chaired by the USCG and the Environmental Protection Agency and functions through inter-agency cooperation, agreements and planning. Although the National Response Team doesn't respond to emergencies, it does serve a planning, policy and coordination function. However, it does have federal-government special teams with expertise in oil and chemical spills, radiological incidents, salvage, public affairs, spill trajectory, occupational safety and other specialized areas. Regional response organizations called Regional Response Teams provide planning and response support, if needed. There are 13 Regional Response Teams throughout the U.S., with one located in the Great Lakes, although responsibility for the Great Lakes is split among three teams.

Region-5's Regional Response Team's area of responsibility is for most of the Great Lakes[17] and is comprised of members from 6 states and 15 federal agencies. Its purpose is to act as a regional planning and coordination body for preparedness and response actions. The Regional Response Team is co-chaired by the U.S. Coast Guard Ninth District (Cleveland, Ohio) and the U.S. Environmental Protection Agency, Region V (Chicago, Illinois).

At the regional level, the U.S. Coast Guard created oil and hazardous substance response advisory and assist teams to comply with Title IV of the *Oil Pollution Act of 1990*. The Response Group is responsible for coordinating maintenance, mobilization and deployment of oil and hazardous-substance resources for response operations. The Advisory Team is deployable and provides logistical and technical support to the federal On-Scene Coordinator. In the Great Lakes, both teams are located at the USCG district office in Cleveland, Ohio.

Federal On-scene Coordinators are federal officials, pre-designated by the Environmental Protection Agency for inland areas and by the USCG for coastal or major navigable waterways. These individuals coordinate all federal containment, removal, disposal efforts and resources during an incident, as well as coordinating federal efforts with the local community's response. Anyone responsible for reporting releases should be aware of which Federal On-scene Coordinator has responsibility for the affected area. For locations near the coast or a major waterway, there may be an On-scene Coordinator from both the USCG and the Environmental Protection Agency with assigned responsibilities within jurisdictional boundaries of various state or local entities. The National Oceanic and Atmospheric Administration provides a Scientific Support Coordinator in coastal and marine areas. This Coordinator serves on the Federal On-Scene Coordinator staff as the lead of a scientific team. This support team provides expertise in environmental chemistry, oil-slick tracking, pollutant transport modeling, natural resources at risk, contingency planning, and liaison to the scientific community and the natural resource trustees.

The USCG has strategically placed pollution-response equipment at its units throughout the Great Lakes. One of the more specialized pieces of equipment available on the Great Lakes is the Vessel of Opportunity Skimming System — a portable side-skimming oil-recovery system that can be deployed from most work vessels over 65 feet in length. It is deployed during exercises and other operational opportunities to ensure its readiness.

17 Region 2 and Region 3 cover the Great Lakes portion of New York and Pennsylvania, respectively. (Environmental Protection Agency website)

5.3.2 Canada's Response System

The Marine Oil Spill Preparedness and Response Regime was established in 1995 to respond to marine oil spills. Transport Canada is designated as the lead federal regulatory agency, and while the framework is built on a partnership between government and industry, it is Transport Canada that sets the guidelines for preparedness and response. Notwithstanding, Transport Canada works with other federal departments and agencies — including Fisheries and Oceans Canada, the Canadian Coast Guard and Environment Canada — to establish the regulatory framework and the mechanisms to prepare for and respond to oil spills in Canada.

The guiding principles of the response regime include the development of comprehensive contingency plans, mutual agreements and the responsibility of the polluter to pay for preparedness and reasonable response costs. Cascading resources are available so that response resources can be obtained from other regions in Canada and from international partners, if needed.

The Canadian Coast Guard (CCG) is the lead federal agency responding to spills. The CCG operates an inventory of marine pollution countermeasures equipment from 10 depots located at strategic points in the Great Lakes-Seaway region. Environment Canada chairs and coordinates the Regional Environmental Emergency Team, which provides environmental, ecosystem and weather data, trajectory modeling and other support.

5.3.3 Canadian/U.S. Joint Response Team

There is a provision in the Joint Marine Pollution Contingency Plan for the formation of a Joint Response Team that is co-chaired by the CCG and USCG, and consists of representatives from each agency. The general functions of the Joint Response Team include: providing advice and counsel to facilitate coordinated planning; preparedness and response to a harmful-substance incident; and preparing debriefing reports and recommendations concerning amendments to the Joint Marine Pollution Contingency Plan or its Geographic Annexes. During an incident, the Joint Response Team will be convened at the request of either the CCG or the USCG's On-Scene Coordinator.

Response operations require the close co-operation of the CCG and USCG On-scene Coordinators to manage and direct response operations by each jurisdiction's private and public sector responders. Either the CCG or USCG's On-scene Coordinator may request a representative from the other jurisdiction to participate as a liaison officer to facilitate the flow of information and to support direct communications. Once requested, a liaison officer will be designated as soon as practicable to report directly to the CCG or USCG's On-Scene Coordinator, as appropriate.

5.3.4 Role of Seaway Corporations

The Saint Lawrence Seaway Development Corporation (SLSDC) and the St. Lawrence Seaway Management Corporation (SLSMC) play a major role in the prevention and response to oil spills along the St. Lawrence Seaway. The SLSDC has an Emergency Response Plan that enhances the Corporation's ability to respond to a vessel incident and it works closely with the USCG, the CCG, the New York State Department of Environmental Conservation and local agencies, in planning, preparation and response to marine emergencies.

Both Seaway Corporations conduct various training exercises for emergency preparedness, and to test emergency response plans, train personnel, and improve communications and co-ordination with other external agencies. For example, in October 2011, the Niagara Region of the SLSMC conducted a full-scale exercise that simulated pollution from a vessel and barge collision in the Welland Canal. Multiple levels of government, supporting agencies and marine stakeholders were involved.

5.3.5 Joint Exercise Example

Each port/marine facility is required to undertake, on an annual basis, a simulated emergency for training and performance-review purposes. For example, Port Windsor undertakes simulated emergency events on a three-year cycle — with one year's event being a table-top simulation, the next year's being a partial field exercise, and the third year's event undertaken as a full-blown simulation with all response personnel and equipment deployed. One such full-scale exercise was a simulated ferry bombing on the Detroit River, with a coordinated planning and response effort under USCG direction. Planning the simulation event took three years and involved 74 U.S. and 60 Canadian planners. The actual exercise led to the involvement of 1,500 U.S. and 1,056 Canadian response personnel, and 40 vessels. The river was closed to vessel traffic for 6 ½ hours during the first day of the event, and for 4 hours during the containment and cleanup response on the second day.

One recent full-scale emergency preparedness exercise was a simulated ferry bombing on the Detroit River, with a coordinated planning and response effort under USCG direction.

5.3.6 First Response Units

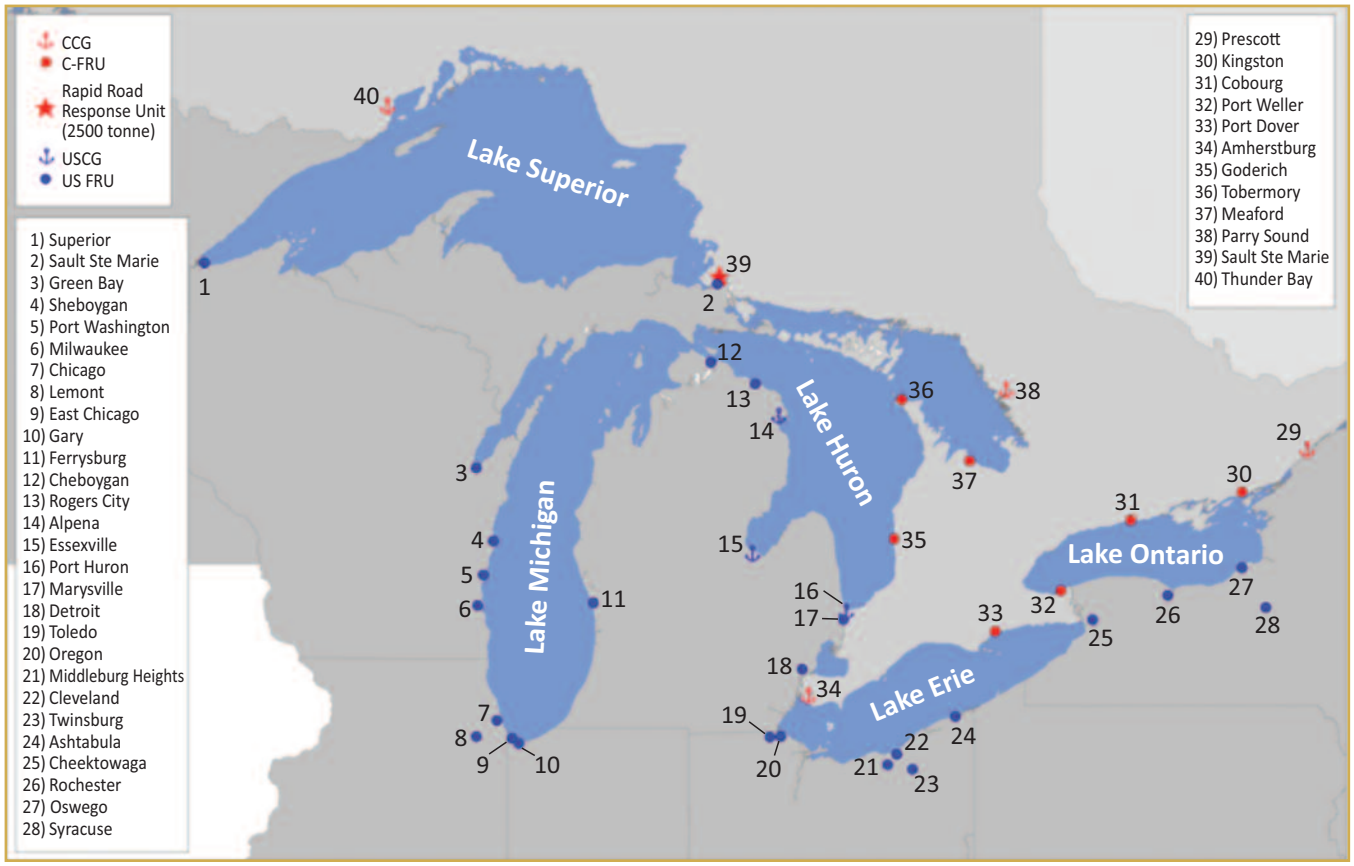
Marine-spill response equipment (containment booms and/or skimmers) is strategically located throughout the Great Lakes-Seaway region and includes both private and public resources. In Canada, the Eastern Canada Response Corporation maintains management, equipment, resources and additional contractor support to respond to any environmental emergencies. In the U.S., similar oil spill response organizations exist. The organizations in both countries are mandated and governed by law, and funded by the Oil Pollution Funds.

Facts related to a recent (2012) Detroit/Windsor joint emergency response training exercise:

- **3 years in planning.**
- **74 U.S. and 60 CDN planners.**
- **1,500 U.S. and 1,056 CDN responders.**
- **40 vessels with booms and skimmers deployed.**
- **Navigation channel closed for 6 ½ hours on day one and 4 hours on day two.**

Figure 3 illustrates a sample of the equipment locations in Canada and the U.S. The full list of sites is not available due to confidentiality restrictions — those shown on the map include private responders on the U.S. side and Coast Guard equipment sites on the Canadian side. (USCG and Canadian private equipment sites are not shown.)

Figure 3. Some of the First Response Equipment Locations on the Great Lakes-Seaway



5.3.7 Private Sector Oil-spill Response Organizations

Responses to small and large spills within established criteria for response times are handled by government-mandated and certified spill-response contractors and organizations. Trained responders and equipment for containment, cleanup and storage exist across the Great Lakes-Seaway geographic area to provide a spill-response capability. While the response structures are slightly different in Canada and the U.S., the goals of implementing a timely and capable response to any spill remain the same.

Amendments to the *Canada Shipping Act* in 1993 strengthened Canada's marine oil-spill response capabilities by requiring all ships in Canadian waters to have a response arrangement with a certified response organization, and with established criteria and processes for certified response organizations.

Canada's major oil companies led this initiative and established four major response organizations. The Eastern Canada Response Corporation is the certified response organization for the Great Lakes. Ships and shipping companies have arrangements in place with the Corporation to respond to pollution incidents with personnel, equipment and other resources, when requested. The Eastern Canada Response Corporation has equipment, personnel and operational management for the containment, recovery and cleanup of oil spilled into the water, including spills related to the loading or unloading of oil from ships. Its equipment includes booms, skimmers, boats, barges, storage facilities, shoreline cleanup and treatment equipment, and communications. It is "certified" to be able to respond to both small and large pollution incidents. Extra equipment can also be cascaded in from other geographic locations within acceptable time frames, as required.

Funding for the response organizations comes from a per-tonne rate charged for all oil cargo loaded/unloaded and through contract arrangement rates with the shipping companies. The original value of equipment and resources for response organizations across Canada was $55 million.

Transport Canada has established regulations and related standards for response organizations that cover defined areas of response, response capabilities, response times, operating environments, and equipment characteristics and requirements. The response organization works at the request of, and under the direction of, the party responsible for the spill. However, all aspects of the response (i.e. the incident management process; development of action-and-response plans; and ongoing status reports) are under the oversight of Transport Canada and the CCG. If the responsible party fails to respond, Transport Canada and/or the Coast Guard may take over control, with the response organization now reporting to them.

In the U.S., an oil spill response organization is defined as "any person(s) who owns or controls oil removal resources designed for or capable of removing oil from the water or shoreline." These organizations provide response equipment and must be able to mobilize and deploy equipment or trained personnel, and remove, store and transfer recovered oil. The use of an oil spill response organization does not relieve the responsible party from overall responsibility for effective and prompt spill response and cleanup.

The guidelines for oil spill response organizations are under the USCG authority and mandated by the *Oil Pollution Act of 1990*. These guidelines were developed to facilitate the preparation and review of vessel and facility oil-spill response plans, with the requirement to have a contractual arrangement in place for personnel and equipment for spill response capabilities.

The oil spill response organizations are classed by geographic area related to the USCG's Captain of the Port zones and/or specific areas within the zone. In the Great Lakes, this would cover the U.S. areas of the lakes and Seaway under the Captain of the Port zones of Sault Ste. Marie, Lake Michigan, Detroit and Buffalo. The oil spill response organizations are subject to USCG inspections, audits and verification.

Safety Performance of the Great Lakes-St. Lawrence Seaway Fleet

1 Approach

The Great Lakes-St. Lawrence Seaway fleet (Canadian, U.S. and international vessels) operates in Canadian and U.S. waters and the combined activity of these vessels can be isolated from that of other regions of the two countries. Marine safety data specific to the Great Lakes-Seaway was, therefore, collected from Canadian and U.S. government sources for the years of 2002 to 2011.

Data on marine occurrences in Canada are reported to the Canadian Transportation Safety Board (TSB) and in the U.S., to the U.S. Coast Guard (USCG). Marine safety data for Canada was obtained from the TSB and for the U.S., from the Marine Casualty and Pollution Database held by the National Technical Information Service. The Canadian TSB data were segmented to include only those vessels that were making a trip into the Seaway. Thus, accidents occurring in the lower St. Lawrence River were included only if the vessel had an origin or destination west of Montreal.

The marine reporting requirements include both transportation-related and employee health- and safety-related incidents (when occurring aboard vessels). Therefore, the data can be segmented into transportation-related casualties and workplace-related casualties. Marine transportation occurrences include vessel events such as strikings, groundings and collisions.

Spills in U.S. waters are reported to the USCG and the data are included in the same Marine Casualty and Pollution Database cited above. Spills in Canadian waters are reported to the Canadian Coast Guard (CCG) and a 10-year history of data was obtained for analysis in this study. Spills were included if they occurred in the Great Lakes-Seaway — which covers the Seaway within Montreal and all Great Lakes-Seaway waters west of Montreal.

Due to the low frequency in the occurrence of fatalities and spills of dangerous goods/hazardous materials in the marine mode, accident rates are based on the total reported occurrences over the 10-year period from 2002 to 2011. Information on workplace safety is presented as the average annual fatalities divided by the number of employees and for spills, presented as the total quantity spilled divided by the total tonne-kilometer (km) of cargo carried over the same period.

The marine safety data were analyzed to separate casualties associated with vessel accidents — which is the basis of data collected for the other transportation modes — from those associated with workplace accidents.

To calculate rates on a tonne-km basis, the 10-year cumulative tonne-km activity data for the Great Lakes-Seaway fleet was estimated by scaling the total cargo tonne-km derived for 2010 by a tonnage-based index. The index was calculated as the ratio of aggregate tonnage reported over the interval 2002-2011 by the U.S. Army Corp of Engineers (USACE) and by the St. Lawrence Seaway Management Corporation (SLSMC), divided by the 2010 tonnage. To avoid double counting of shipments in the U.S. data, the total tonnage reported for the Seaway was reduced by 45%, as an estimate of the portion of tonnage that is handled by U.S. Great Lakes ports.

The index inherently assumes that Canadian domestic cargo not transiting the Seaway locks system is reasonably represented by the same index. The annual data in tons/tonnes carried are shown in **Table 1**. The 10-year cumulative marine-cargo index is multiplied by the 2010 cargo activity (145.7 billion cargo-tonne-km/99.89 billion cargo ton-miles, as derived in the Environmental and Social Impacts study[18]), in order to calculate the cumulative cargo-tonne-km over the 10-year interval. The resulting index of 13.41 indicates that the 10-year cumulative cargo-tonne-km was 13.41 times the 2010 cargo-tonne-km (i.e. 2010 was a lower-volume traffic year for the decade). An estimated 5,217 loaded trips were made in 2010, which scales via the 13.41 multiplier in **Table 1** to 69,960 trips over the 10-year data interval.

Table 1. Representative 10-year Index of Tonnage Carried on the Great Lakes-Seaway (2002-2011)

Year	U.S. Great Lakes Domestic		U.S. Great Lakes Involved at one end		Non-U.S. Seaway Tonnage*		Total Indexed to 2010
	Tons in Millions	*Tonnes in Millions*	*Tons in Millions*	*Tonnes in Millions*	*Tons in Millions*	*Tonnes in Millions*	
2002	50.8	46.1	59.6	54.1	21.0	19.0	1.50
2003	44.9	40.7	56.3	51.1	20.7	18.8	1.39
2004	51.8	47.0	62.2	56.4	22.0	20.0	1.55
2005	48.1	43.6	61.4	55.7	22.0	19.9	1.50
2006	48.5	44.0	63.2	57.4	23.9	21.7	1.54
2007	47.8	43.4	54.2	49.2	21.8	19.8	1.41
2008	45.2	41.0	52.2	47.4	20.7	18.8	1.34
2009	31.6	28.7	37.1	33.7	15.6	14.1	0.96
2010	36.4	33.0	32.9	29.9	18.5	16.8	1.00
2011	45.5	41.3	43.2	39.2	19.0	17.3	1.23
10-year Cumulative Index							**13.41**

Sources: USACE, Waterborne Commerce Statistics; and SLSMC, Annual Traffic Statistics.

* Non-US tonnages are estimated on the basis of 45% of Seaway tonnage involving U.S. Great Lakes ports, which was the ratio for 2011.

18 *Environmental and Social Impacts of Marine Transport in the Great Lakes-St. Lawrence Seaway Region*, Research and Traffic Group (January 2013)

2 Marine Accidents in Canadian and U.S. Waters

All accidents and safety-related occurrences in Canadian waters are reportable to the Canadian Transportation Safety Board (TSB) and to the U.S. Coast Guard (USCG) in U.S. waters.

A total of 801 vessel accidents (defined as a collision, striking or grounding) were reported in the combined Canadian and U.S. waters of the Great Lakes-Seaway for the years of 2002 to 2011. The data are presented in **Table 2** for total number of accidents reported in Canadian and U.S. waters.

Table 2. Marine transportation-related accidents reported in the Canadian and U.S. Waters of the Great Lakes-Seaway (2002-2011)

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total
Waters of:											
Canada	31	19	33	34	27	26	26	20	23	32	**271**
U.S.	1	19	41	40	90	119	64	46	69	41	**530**
Total	**32**	**38**	**74**	**74**	**117**	**145**	**90**	**66**	**92**	**73**	**801**

Source: Derived from USCG Marine Casualty and Pollution Database and TSB Marine Occurrences Database.

The U.S. data indicate whether the vessel was damaged as a consequence of the accident and those data indicate that 59% of the accidents resulted in no damage to the vessel. The TSB data do not indicate damage but are classified with severity being a factor in the classification. For the 271 marine accidents in Canadian waters, 97.5% were classed at the minimum ranking and the other 2.5% were ranked at below mid-ranking.

For the 10-year period of 2002 to 2011, no fatalities and only two injuries occurred due to shipping accidents in the combined U.S. and Canadian waters in the Great Lakes-Seaway. Based on a total number of vessel trips of 69,960 over the 10-year data interval, 100% of trips were fatality-free and 99.997% were injury-free in relation to shipping accidents.

The casualty numbers for the Great Lakes-Seaway fleet and corresponding per-tonne-km and per-ton-mile rates are summarized in **Table 3**.

Based on a total number of vessel trips of 69,960 over the 10-year data interval, 100% of trips were fatality-free and 99.997% were injury-free in relation to shipping accidents.

Table 3. Great Lakes-Seaway Fleet Casualty Rates Due to Marine Transportation-related Accidents per Cargo-tonne-km/ton-mile (2002-2011)

Measure	Vessel Flag of Registry	Fatalities	Injuries
Number	Canada	0	2
	U.S.	0	0
	Other	0	0
	Total	0	2
Total Rate per 100-billion tonne-km		**0**	**0.10**
Total Rate per 100-billion ton-miles		**0**	**0.15**

Source: RTG analysis of Canadian TSB and USCG accident data.

2.1 Comparison of Marine and Rail Casualty Rates Due to Transportation-Related Accidents

Marine shipping accidents can be further assessed in terms of cargo tonne-kilometres (or cargo ton-miles) and benchmarked against comparable rates for the rail mode.

Railway crash data include fatalities from three sources: train derailments/collisions; highway grade crossing collisions; and trespass collisions. It should be noted that some of the trespass collisions could be suicides; however, although suicides are recognized as occurring on railway property, it is not possible to determine the actual proportion of trespass fatalities that can be attributed to suicide.

Railway crash data in Canada are reported to the Canadian TSB and activity data in terms of tonne-km carried are reported for freight railways by the Railway Association of Canada. Data for the Great Lakes-Seaway region could not be isolated because the underlying tonne-km of railway activity is only published at the national level. A data extract was obtained from the TSB for railway accidents, excluding passenger trains, for the interval 2002-2011. Note that employee fatalities and injuries are associated with reportable accidents involving railway equipment and do not include workplace accidents related to track maintenance.

Railway crash and operational data are reported to the Federal Railroad Administration in the U.S. Railway casualty rates are reported on a train-mile basis in the accident data. The data were analyzed for Class 1 railways, with passenger train casualties removed — and with net-ton-miles as the activity basis for the rate calculation.

There are some areas of difference between the U.S. and Canadian railway casualty data that warrant discussion. Unlike the Canadian railway data, employee casualties in the U.S. include workplace accidents related to track maintenance. Nonetheless, the employee fatality rates are quite close for the two countries. The overall injury rate in the U.S. is significantly higher and part of the difference might be explained by population density. However, the higher U.S. injury rates are also influenced by the fact that the Canadian data only include serious injuries, while the U.S. data includes all reported injuries. The U.S. overall injury rate for the 10-year time interval is also significantly influenced by a single derailment in 2002 that led to a release of a hazardous materials substance in a populated area — which in turn led to 1,442 reported skin-rash injuries (and one fatality).

Table 4 shows that the rate of collision-related injuries per 100-billion tonne-km for marine transportation in this region is 17 times lower than the national rate for Canadian freight railways and 70 times lower than the national rate for U.S. Class 1 freight railways.

Table 4. Comparison of Marine and Rail Injury and Fatality Rates for Transportation-related Accidents (2002-2011)

Mode	Injuries	Fatalities
Rate per 100-billion tonne-km		
Marine – Great Lakes-Seaway Vessels	0.10	0
Rail – Cdn Freight Railways	1.78	0.64
Rail – U.S. Class 1 Freight Railways	7.0	0.65
Rate per 100-billion ton-miles		
Marine – Great Lakes-Seaway Vessels	0.15	0
Rail – Cdn Freight Railways	2.59	0.94
Rail – U.S. Class 1 Freight Railways	10.2	0.95

Source: RTG analysis of Canadian TSB accident data and Federal Railway Administration casualty database and ton-mile data from the U.S. Department of Transport, Bureau of Transportation Statistics, Appendix D: Rail Profile.

Note: The cargo-ton-mile activities were not available for 2010 and 2011 — they were estimated by applying the ratio of cargo-ton-miles/train-mile for 2009 to the available train-mile data for 2010 and 2011.

3 Workplace Safety Benchmarking

The Great Lakes-Seaway marine safety performance can be benchmarked against other modes in the transportation sector, as reported annually by the U.S. Department of Labor, Bureau of Labor Statistics (Census of Fatal Occupational Injuries and Industry Injury and Illness Data). For the 10-year period of 2002 to 2011, a total of 5 employee fatalities occurred while onboard vessels - 2 onboard Canadian-flagged vessels and 3 onboard U.S.-flagged vessels. **Table 5** compares the derived 10-year average fatality rates for Great Lakes-Seaway mariners with the fatality rates reported for other U.S. freight modes from 2002 to 2011.

Workplace safety can be measured on the basis of the number of fatalities resulting from workplace injuries and sicknesses. Workplace safety performance is compared on the basis of fatality rates per 100,000 workers. Fatality rates were derived specific to the Great Lakes-Seaway (including both U.S.- and Canadian-flagged vessels). The numerators are the average annual work-related fatalities occurring in either U.S. or Canadian waters of the Great Lakes-Seaway over the 10-year interval of 2002 to 2011. The denominator for the Great Lakes-Seaway rates is based on 7,629 onboard employees in the Great Lakes-Seaway in 2010 as cited by Martin Associates[19] and scaled by the 10-year tonnage-carried index of 13.41 derived in **Table 1**. The 5 fatalities from workplace activities translate into an average rate of 4.9 per 100,000 workers.

The actual fatality rates for each transportation sector, as well as the rates when indexed to the rate on the Great-Lakes Seaway, are shown in the table below. The Great Lakes-Seaway mariner fatality rates are the lowest of all freight modes:

- The U.S trucking sector fatality rate was 5.5 times higher than the Great Lakes-Seaway mariner rate;
- The fatality rate for the U.S. rail transportation sector was 1.5 times higher than the Great Lakes-Seaway mariner rate.

In relation to other benchmarks in the U.S. Department of Labor data, the Great Lakes-Seaway rate is lower than the average fatality rate for all employed males in the U.S. — which was 5.7 fatalities per 100,000 full-time-equivalent employees in 2011. Fishermen (and related fish workers), who work in the same physical environment as cargo vessels — but perhaps with different safety cultures, vessel strengths and regulatory frameworks — have the highest fatality rate of all occupations at 127.3 fatalities per 100,000 full-time-equivalent employees in 2011. A similar workplace safety comparison against other Canadian freight modes was not possible due to a lack of consistent and comparable government information.

Table 5. Marine Employee Workplace Safety Benchmarking with Other U.S. Freight Modes (10-year average fatality rates, 2002-2011)

Freight Transport Mode	Fatalities	
	Rate (#/100,000-workers)	*Indexed to GL-S Marine*
U.S. Long Distance Freight Truck	26.7	5.5
U.S. Transportation and Warehousing Average	15.6	3.2
U.S. Scheduled Air Cargo	7.45	1.5
U.S. Rail Transportation	7.24	1.5
Great Lakes-Seaway Mariners	**4.9**	**1.0**

Sources: Great Lakes-Seaway rate was a derived 10-year average using fatality data from TSB and USCG and employment data for 2010 from Exhibit II-6 of Martin Associates, *The Economic Impacts of the Great Lakes-St. Lawrence Seaway System*, October 2011, which was scaled with the 10-year tonnage-carried index of 13.41. All other rates are averages of annual census data published by the U.S. Department of Labor, Bureau of Labor Statistics.

Notes:

1. Marine casualties are those of the combined U.S. and Canadian waters of the Great Lakes-Seaway and include Canadian and U.S. fleets.Employee workplace fatalities exclude 3 fatalities resulting from previously existing medical conditions that are reported in the marine data but are not included in the chart as they are not "workplace casualties" as defined in normal labor statistics.
2. Truck data for fatalities includes all types of trucks (local delivery as well as long-distance combination trucks) in one average.
3. U.S. scheduled air was aggregated in earlier years of the data, whereas cargo-only rates were available in later years.

19 Martin Associates, *The Economic Impacts of the Great Lakes-St. Lawrence Seaway System*, October, 2011 (Exhibit II-6).

4 Dangerous Goods/Hazardous Materials Spills Analysis

Spills of dangerous goods in Canada and hazardous materials in the U.S. are reported to the respective Coast Guards. However, the marine mode also reports releases of other substances, such as road salt and coal, which are not categorized as dangerous goods/hazardous materials. The data have been analyzed to identify and retain only the dangerous goods/hazardous materials releases.

4.1 Marine Spills in Canadian and U.S. Waters (All Vessel Types)

There were 73 reported releases from vessels in Canadian Great Lakes-Seaway waters and 66 releases in U.S. Great Lakes-Seaway waterways over the period of 2002 to 2011. Incidents were mainly related to relatively small spills of product during loading/unloading operations or minor releases of consumables involving hydraulic fluid, lubricating oil or fuel oils.

Based on a total number of vessel trips of 69,960 over the 10-year data interval, 99.8% of vessel trips were "incident-free" — in terms of releases of dangerous goods/hazardous materials. **Table 6** presents the dangerous goods/hazardous material spills reported in combined U.S. and Canadian waters between 2002 and 2011.

The severity of spills is reported differently across transportation modes and many modes do not report release quantities. The total reported damages resulting from marine spills were $351,000 between 2002 and 2011.

Table 6. **Dangerous Goods/Hazardous Materials Spills in the Canadian and U.S. Waters of the Great Lakes-Seaway (2002-2011)**

	Canada	U.S.	Total	Avg/Year
Spills Reported	**73**	**66**	**139**	**14**
Quantity – Litres	20,291	17,165	37,456	3,746
Quantity – U.S. gallons	5,361	4,534	9,895	990

Source: RTG analysis of the CCG Pollution Information database and USCG Marine Casualty and Pollution database for spills occurring in Great Lakes-Seaway waters — west from, and including Montreal-area locks.

4.2 Spill-free Performance of Tanker Vessels and Barges

The spill-free performance of all tanker vessels and barges operating in the Great Lakes-St. Lawrence Seaway was 99.99% for the 10-year period of 2001 and 2012.

For the 10-year period of 2002 to 2011, the quantity of spills occurring on tank vessels and barges (i.e. during loading or unloading operations, or minor releases of consumables) totaled 9,574 litres (2,522 U.S. gallons) in Canadian waters and 4,046 litres (1,071 U.S. gallons) in U.S. waters. The combined spill rate is equivalent to 157 milliliters (about 10.5 tablespoons) per million litres of product carried — or 2.5 cups for every million U.S. gallons carried. These rates are based on pro-rating over the 10-year period, the 2010 carriage of 5.4 million tonnes of bulk liquid products on the Great Lakes-Seaway and assume an average specific gravity of 0.84 for the liquid products.

On an annual basis, the quantity of spills occurring on tank vessels in Canadian and U.S. waters was 1,362 litres (360 U.S. gallons) per year. This annual amount is equivalent to 1.2% of the capacity of a single rail tank car (i.e., 113,000 litres/30,000 U.S. gallons).

4.3 Analysis of Spills in Canadian Waters

Dangerous goods spills on the ground are reported to the Dangerous Goods Directorate of Transport Canada, while pollution spills (including non-dangerous goods) occurring on water are reported to the CCG. The marine pollution data were reviewed to eliminate double counting of incidents reported in U.S. waters. The 73 reported releases from vessels in Canadian Great Lakes waters over 2002-2011 are summarized in **Table 7**.

Table 7. Dangerous Goods/Hazardous Materials Spills in the Canadian Waters of the Great Lakes-Seaway (2002-2011)

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total
Litres	5	3,035	159	1,438	5,185	530	569	530	8,088	752	**20,291**
U.S. Gal	1	802	42	380	1,370	140	150	140	2,137	199	**5,361**

Source: RTG analysis of the CCG Pollution Information database.

The majority of spills involved petroleum releases that were mostly spills of fuel oil or lubricating oil from the vessel's engine fuel bunkers. Some of the barge incidents involved release of product that was being transported and those occurred during transfer at ports/terminals. The two dominant barge incidents were a spill of 3,975 L (1,050 US gal) of oil during transfer at an oil terminal and a spill of 2,385 L (630 US gal) of asphalt at a dock transfer.

The main tanker release was a 1,200 L (317 US gal) release of hydraulic fluid in a Seaway lock. Two other releases of 455 L and 400 L (120 US gal and 106 US gal) occurred at oil-handling terminals and five other small releases totaling 285 L (75 US gal) occurred in the Great Lakes-Seaway over the 10-year study period.

The remaining spills of petroleum products were all spills of onboard consumables by non-tank vessels. The bulk-vessel spills were dominated by a CCG-estimated spill of 8,000 L (2,113 US gal) of fuel oil, following an accident where a vessel lost engine power in strong winds and overrode its anchor.[20] The remaining 2,618 L (693 US gal) came from 43 other small-release incidents involving a mix of hydraulic fluid, lubricating oil and fuel oils.

4.4 Analysis of Spills in U.S. Waters

In the U.S., hazardous materials spills on water are reported to the USCG and available in the Marine Casualty and Pollution Database. The U.S. database contains more details on the severity of the spill than were available from the CCG database. The databases were reviewed for the Great Lakes-Seaway waters and those states bordering the Great Lakes. The marine data include cargo releases that are not dangerous goods/hazardous materials. The largest releases reported involved barge-loads of calcium chloride (i.e. road salt). The Great Lakes-Seaway data also include incidents that occurred on tributary rivers and canals. These categories (non-dangerous goods cargo and inland rivers) were segmented in the data. Much of the activity on the rivers/canal systems involve barges that strictly operate on the rivers and canals. Spills occurring on the tributary rivers, canals and harbors were only included if they involved a Great Lakes bulk-cargo vessel or a barge of 2,000 gross registered tonnage (GRT) or higher.

20 The operator's estimate of the release quantity was 1,000 L, not the 8,000 L estimated by the CCG. RTG's analysis uses the CCG database value.

Table 8 summarizes the 10-year aggregate spills and releases of petroleum products and dangerous goods in the U.S. Great Lakes-Seaway waterways and by deep-draft cargo vessels in inland rivers and canals.

Table 8. Dangerous Goods/Hazardous Materials Spills in the U.S. Waters of the Great Lakes-Seaway (2002-2011)

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total
Litres	42	2,788	1,108	579	140	11,966	178	12	142	210	**17,165**
U.S. Gal	11	736	293	153	37	3,161	47	3	38	56	**4,535**

Source: RTG analysis of the USCG Marine Casualty and Pollution database.

There were 45 spills in U.S. Great Lakes-Seaway waterways totaling 1,259 US gal (4,761 L) — and 21 spills in the inland canals and rivers totaling 3,275 US gal (12,380 L). Spills in the inland canals and rivers accounted for 72% of the quantity released.

Barges were responsible for 85% of the quantity spilled in Great Lakes-Seaway waters and about two-thirds came from one spill of 700 US gal (2,646 L) from a tank barge in 2003. Bulkers and other motorized vessels accounted for 80% of the spill incidents in Great Lakes-Seaway waters but only 15% of the total quantity spilled.

Of note is that only one tank ship was involved in a spill and it was a small tanker refueling a tugboat on an inland canal; however, the spill of 50 US gallons was attributed to the tugboat, as the captain ordered an incorrect quantity of fuel.

The spill quantity and damages from deep-draft vessels on rivers and canals were dominated by a fuel release from a bulk-cargo vessel, following a striking event on a river. This was the only "vessel accident" event in the spill occurrences over the 10-year interval, and accounted for all the river/canal waterway damages and 95% of the quantity spilled in rivers/canals by deep-draft vessels over the 10-year interval.

As noted above, release of dangerous goods/hazmat products in transit by tank ships was almost non-existent and all reported incidents could have been releases of onboard consumables, rather than transported products. The largest single release was 1,200 L (317 US gal) of hydraulic fluid and two other releases of 455 L and 400 L (120 US gal and 106 US gal) occurred at oil-handling terminals. Five other small releases totaling 285 L (75 US gal) occurred in the Great Lakes-Seaway over the 10-year study period.

Closing Comments from the Study Authors

It is clear from our analysis that the Great Lakes-Seaway marine system operates under a well-established safety framework, has coordinated bi-national response programs/procedures in place and over the past decade its operators have demonstrated an exemplary safety record. Great Lakes-Seaway overseers and operators have shown initiative in developing safety training programs and leadership in testing/adopting new technology. In benchmarking with other modes, the Canadian, U.S. and international vessels operating on the Great Lakes-Seaway were found to exceed the safety performance of other freight transport modes in both safe transportation and employee workplace safety. In every area that benchmarking data were available, Great Lakes-Seaway operators essentially set a safety-performance benchmark that other modes could strive to attain.

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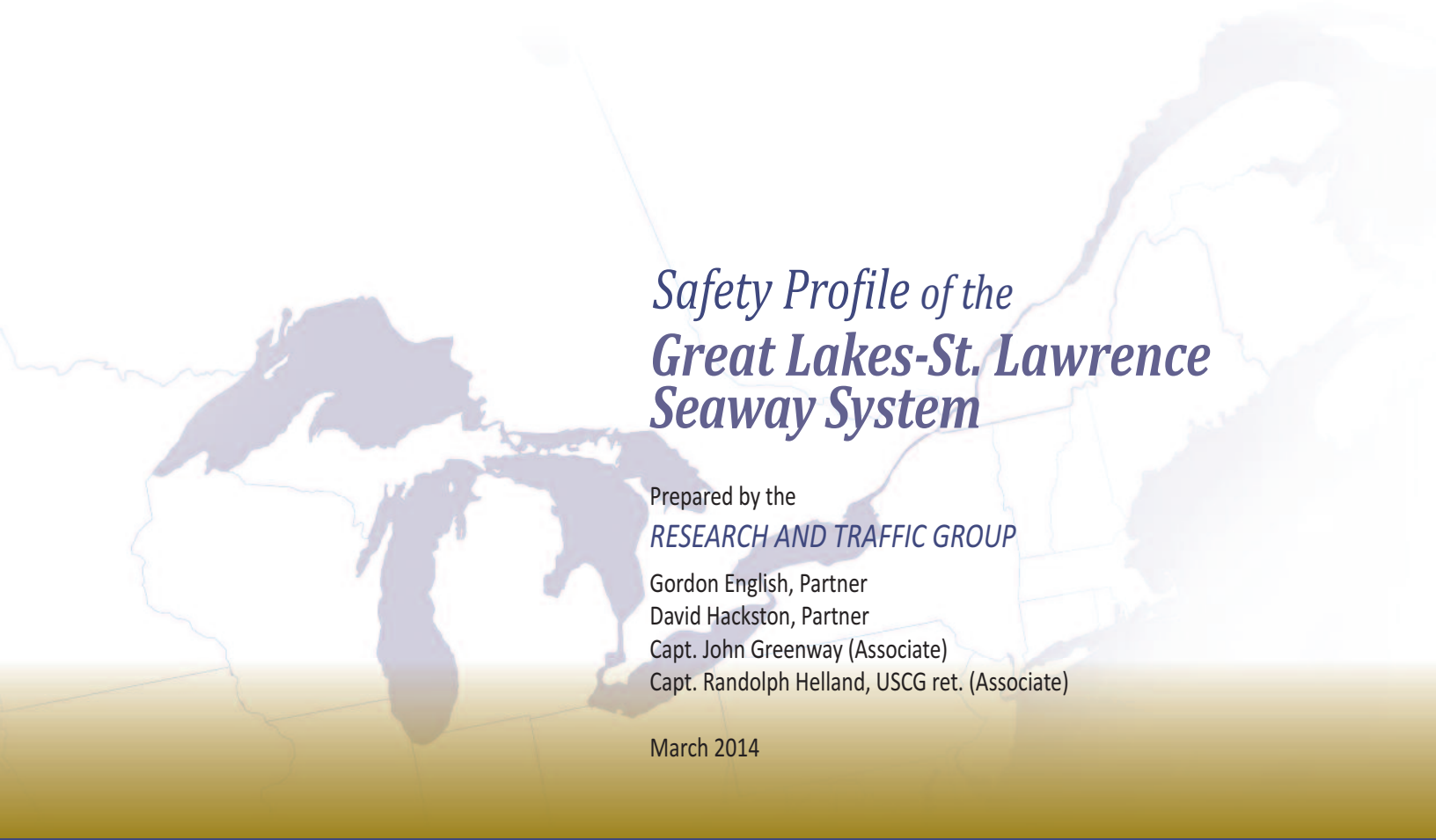

Safety Profile of the ***Great Lakes-St. Lawrence Seaway System***

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